3s. 6d.

Light and **Lighting**

October 1961

The latest Atlas Lighting Fittings made from 'Diakon' Polymer

Field & Company, Fruit Merchants Ltd., Turban House, 36/38 Botolph Lane, London E.C.3

Vick International Ltd., 10 New Burlington Street, London W.1.

Longmans, Green & Company, imited, 48 Grosvenor Street, London W.1.

All fittings illustrated here are Atlas Fluorescent Fittings made by Atlas Lighting Ltd., Thorn House, Upper St. Martin's Lane, London W.C.2. The diffusers are moulded from 'Diakon' I.C.I. acrylic polymer.

These three modern offices have lighting fittings made from an equally modern material—'Diakon'. 'Diakon' polymer is being used for many of Britain's most advanced lighting fittings, for diffusers, bowls, refractors and louvres. The production of 'Diakon' polymer for injection moulding and extrusion, together with the development of new techniques, mean that high quality fittings can be made from 'Diakon' at lower-than-ever cost. For more information about this material and the Technical Service available, ask your local I.C.I. Sales Office.

Lighting fittings made from 'Diakon' have all these advantages :-

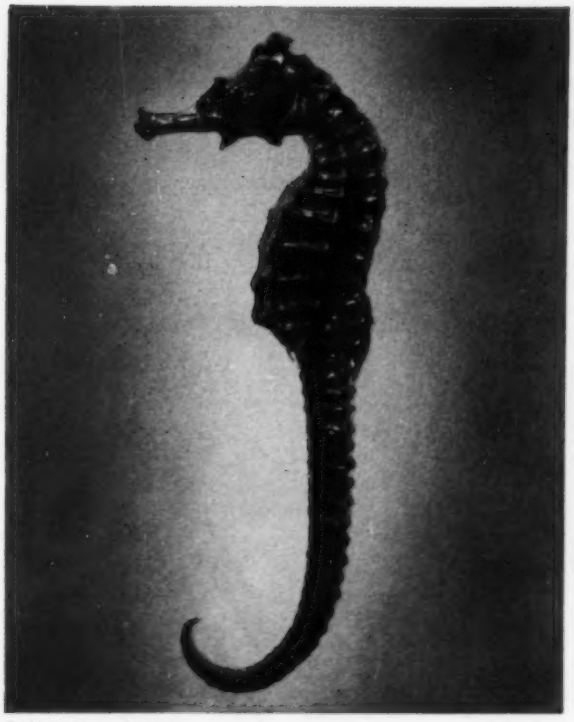
- ✳ Excellent optical properties.
- ✳ High impact strength.
- ✳ Light weight, making 'Diakon' fittings easy to install.
- ✳ Dimensional stability.
- ✳ Attractive appearance. A fitting made from 'Diakon' looks good—and stays that way.

'DIAKON' POLYMER

'Diakon' is the registered trade mark for the acrylic polymer manufactured by I.C.I. DH21

IMPERIAL CHEMICAL INDUSTRIES LIMITED · LONDON · S.W.1

ICI



Quality in Nature. Sea-horse

CRYSELCO

lamps and fittings can be obtained from any of fourteen branches and depots throughout the country.

All CRYSELCO business is based upon a policy of Quality and Service.

This attention to detail in production and distribution, coupled with more than 60 years' experience in lamp manufacture, ensures quality products, promptly delivered.

The range of lamps and fittings available is extensive. If you have not received the current catalogue, please send for one today.

QUALITY and SERVICE

CRYSELCO BRANCHES
are situated throughout the country.

Their aim is to give you quality products plus good service.

CRYSELCO Managers in the following towns and cities would be pleased to hear from you.

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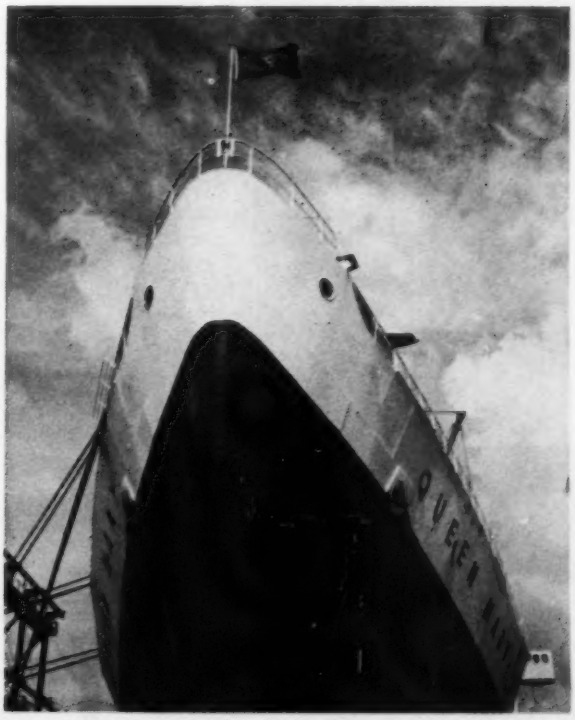
CRYSELCO LIMITED
KEMPSTON WORKS BEDFORD

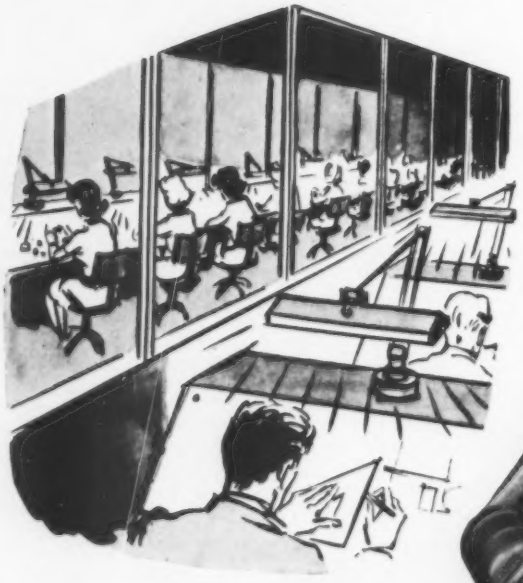


Service by Sea, Queen Mary (Photo Cunard Steamship Co Ltd)

Spotline

ADJUSTABLE FLUORESCENT REFLECTORS

for Local Lighting



Available in two sizes, this improved version of the SPOTLINE Reflector includes the following important advantages:

1. **Higher illumination**
2. **Built-in control gear in base**
3. **Robust reflector**
4. **Wide range of adjustment**
5. **Spring counter-balance**
6. **Dual-purpose ON/OFF starter Switch**
7. **Totally enclosed wiring**

THE IDEAL UNIT FOR INTRICATE WORK

Standard Lengths and Prices (Including Control Gear)

Cat. No.	Length	Type of Tube (extra)	Price (A)
SL.9/2	10"	2—9" × 6w	180/–
SL.18/2	18¾"	2—18" × 15w	190/–

LINOLITE

WRITE FOR ILLUSTRATED LEAFLET No. 49

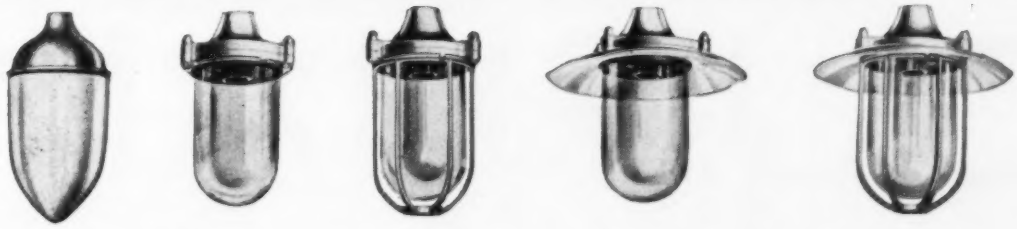
LINOLITE LIMITED

Sales & Export Depts., Showroom & Trade Counter:
118 BAKER STREET, LONDON, W.1. Telephone: WELbeck 1159 & 1150

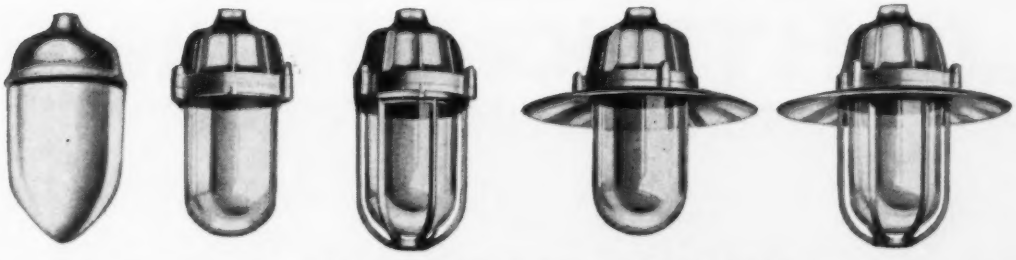
Head Office & Factory:
THE MILL WORKS, MALMESBURY, Wilts. Telephone: 2240

COUGHTRIE

Weatherproof
LIGHTING FITTINGS
AND ACCESSORIES



Always better than they have to be



MANUFACTURED AT HILLINGTON, GLASGOW, S.W.2 *by*

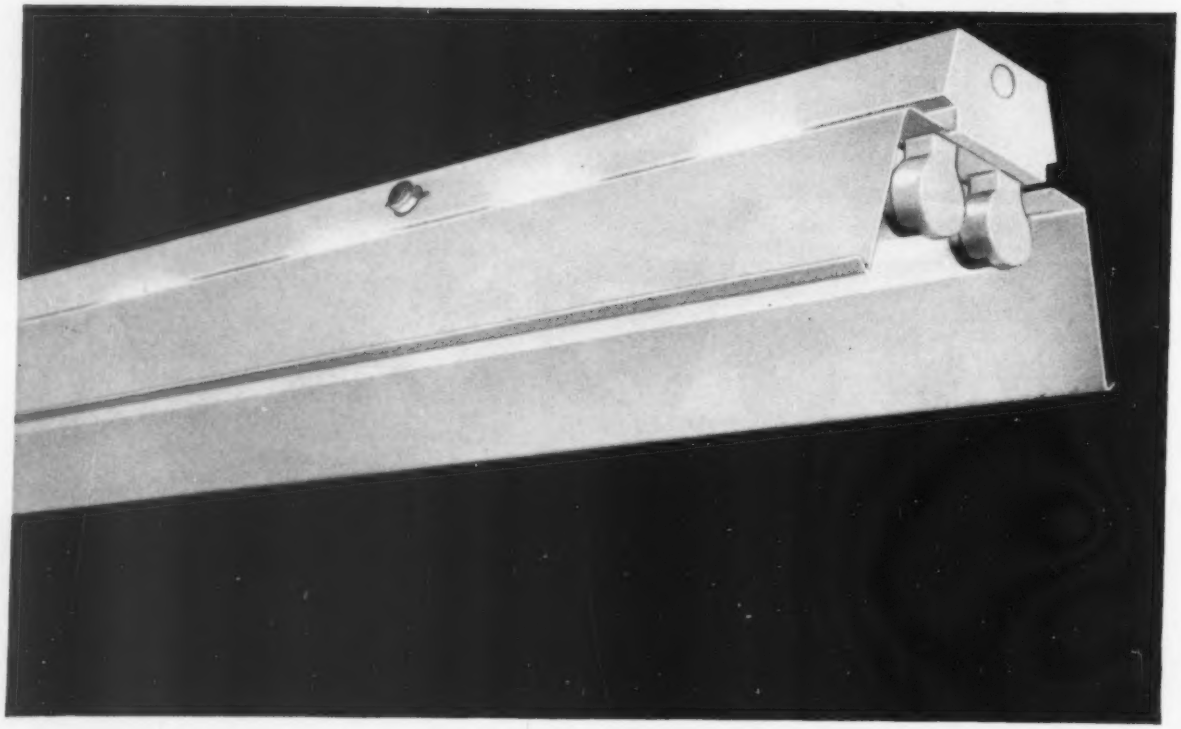
J. & G. COUGHTRIE Ltd.

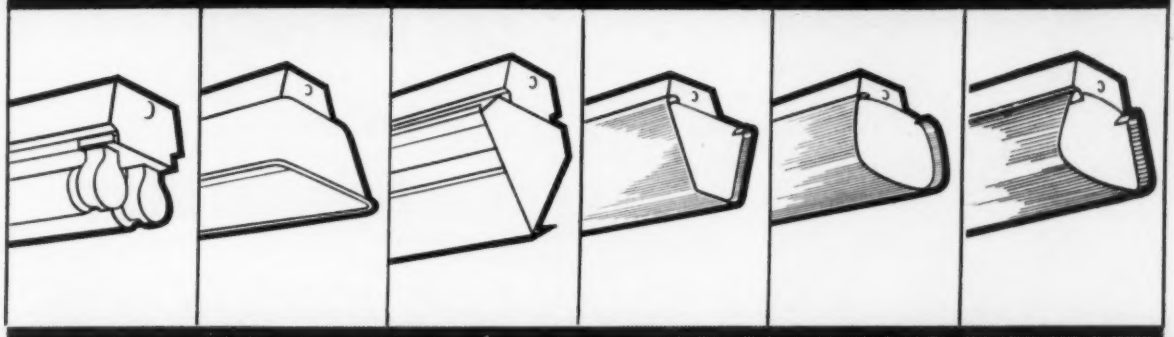
CATALOGUE AVAILABLE ON REQUEST

NEW

DURHAM RANGE

LIGHTING FITTINGS





a complete and compact range

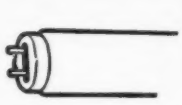
- ✻ Switchstart and quickstart throughout range
- ✻ Easy installation and maintenance
- ✻ Superbly engineered

PRODUCED BY **EKCO**

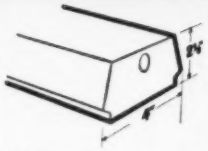
- ✻ Competitive price
- ✻ Quality materials and manufacture
- ✻ Wide range of quick-fix reflectors and diffusers

LIGHTING ADVISORY SERVICE
Ekco-Ensign operates a Lighting Advisory Service throughout Great Britain. Qualified Lighting Engineers will be pleased to call on you, discuss your particular problem and to prepare detailed lighting schemes. This service is entirely free and without obligation.

EASY ASSEMBLY AND MAINTENANCE

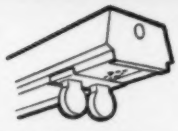


Tubes
For 8 ft., 5 ft. & 4 ft. single and twin.
Also 85W 8 ft. twin.

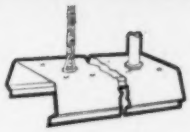


Spine
Identical strong shallow section for all tube sizes—single and twin.

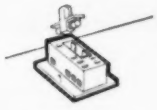
Packing
All fittings separately cartoned. Lampholder platforms ready-wired packed in spine.



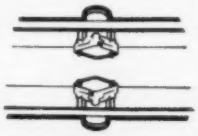
Lampholder Platform
Platform locked into position without tools. Lampholders cannot be reversed on twin fittings.



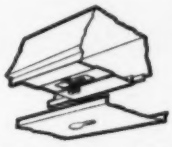
Installation
For chain, conduit or direct-on-ceiling. Knockout at centre and in endplates.



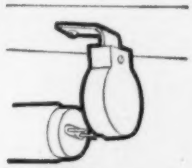
Fused Terminal Block
3-way block for fitting protection — easily replaceable B.S. cartridge fuse.



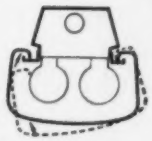
Starter Switches
Instantly accessible without dismantling fitting.



Reflectors & Cover Plates
Quickly and easily attached by a simple locking device.



Lampholders
White, plastic, sprung, bipin for positive operation.



Diffusers
Positively attached to spine by simple swing-over action.

EKCO-ENSIGN ELECTRIC LIMITED. 45 Essex Street, Strand, London WC2 Telephone: CITy 8951

Sales Offices, Illuminating Engineering Depts., Showrooms and Depots LONDON · MANCHESTER · BIRMINGHAM · NOTTINGHAM · GLASGOW · CARDIFF

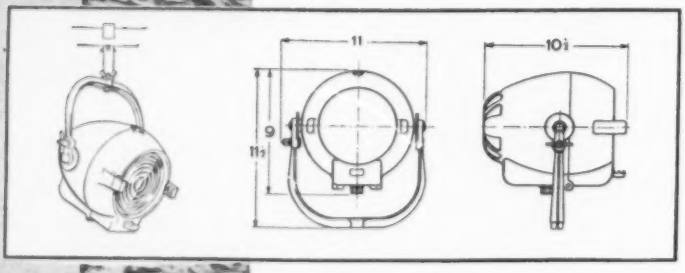
LIGHTING FOR ENTERTAINMENT

Ideally this type of lighting should be built in. Often this is not practicable. For example, rostrums in town halls or temporary stages in public assembly halls can often be effectively lit only from lanterns in full view of the audience.

In such cases the Strand Baby Spot, illustrated here, provides the only really satisfactory answer. It is a neatly styled, compact lantern quite unobtrusive and capable of a higher light output than many much bulkier lanterns.

Strand engineers offer free advice on planning all such specialised lighting and a fully equipped contracts and wiring department to carry out the installation. You will almost certainly find it useful to have our new catalogue of lighting control equipment and lanterns by you. It includes all optical and mechanical data and prices from which specifications and estimates can be prepared. May we send you a copy? and if you have not already received one, copies of 'Stage Planning 1961' are also available.

Strand Patt. 123 and 23 Baby Spots are neatly styled and of small dimensions so that concealment is often unnecessary.



The above illustration shows a Strand all-electric Saturable Reactor Remote Dimmer Control in use at Adelaide University. This control requires little maintenance and being extremely compact is ideal for small lighting installations up to 54 ways. This type of dimmer accounts for 5,000 of the 16,000 remote controlled Strand dimmers in use.

STRAND ELECTRIC

THE STRAND ELECTRIC & ENGINEERING CO. LTD.

29 KING STREET, COVENT GARDEN, W.C.2. TEMPLE BAR 4444

G.E.C. lights Auckland harbour bridge

"A sparkling link between the harbour shores"—that's how an Auckland newspaper sees the city's new bridge, romantically, after nightfall. To the G.E.C. it is another big overseas lighting contract successfully completed. It follows the now famous achievement in lighting Niagara Falls. It will itself be followed by other equally impressive installations, for the G.E.C. Lighting Division is a world leader in exterior lighting, looking for new worlds to conquer.

Navigational safeguards and road safety were important factors in this installation. Specially designed cut-off lanterns installed on the bridge structure of the central navigational span keep the light on the roadway and away from passing ships. In all, nearly 350 G.E.C. lanterns and Osram sodium lamps light this bridge and the approaches.

G.E.C.
LIGHTING
AND
HEATING
GROUP

THE GENERAL ELECTRIC CO. LTD., MAGNET HOUSE, KINGSWAY, LONDON, W.C.2

HORSTMANN TIME SWITCHES

automatically control

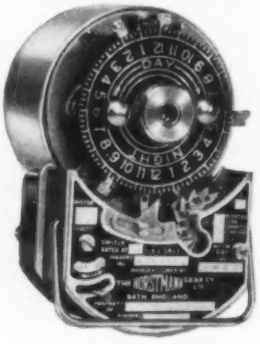
STREET LIGHTING		
SHOP WINDOW LIGHTING		
IMMERSION HEATERS		
FACTORY YARD LIGHTING		
	* NEON SIGNS	
* NEON SIGNS	SPACE HEATING	OFF PEAK TARIFFS

Dusk means different things to different people. Romance. Food. The start of the night shift. Or . . . Frying 8 p.m.—Dolores Hair Fashions—Members Only—Hot Pies—Regency Bar—All Night Service . . . that's what dusk means to Horstmann. Why? Because controlling neon signs is just one of the many jobs performed by Horstmann Time Switches. Performed very efficiently too, for Horstmann have a reputation for accuracy all over the world. And reliable? Well, you can draw your own conclusions from watching the signs in *your* town come on at dusk . . . regular as Horstmann.

Some of the other electrical appliances controlled by Horstmann Time Switches are shown above. What we really need however is a neon sign stating "Impossible to show everything we do . . ." for there are Horstmann Time Switches for controlling practically any appliance that needs to be switched on and off entirely automatically without attention.

The Horstmann Type K Mark II Time Switch

is used extensively for controlling neon signs. The high precision synchronous motor driven movement has a capacity at 250 volts 50 cycles of 20 amps A.C. for tungsten loads. A selective device can be supplied to prevent operation on any specified day or days of the week. The unit is available in a neat moulded or metal box, or with a clear moulded push-on cover or with hinged drum cover. Please write for full details of the switch best suited to your particular requirements, giving as much information as possible about the application.



HORSTMANN

THE HORSTMANN GEAR COMPANY LIMITED

NEWBRIDGE WORKS · BATH · Tel: 7241

HG14

AEI
illuminate
the new
IES Code

FREE

If you have anything to do with lighting specifications, you almost certainly know about the new I.E.S. Code. ✻

Now A.E.I. have produced a Lighting Performance Data Sheet to be used with the new code, to help you plan the most precise and up-to-date lighting installations.

Most of the data relates to the A.E.I. Series 2 fluorescent fittings. Exacting engineering and simplicity of design have made these fittings the choice of all really enlightened lighting experts.

Ask A.E.I. for your free copy of this helpful, lucid material. Write to the A.E.I. Lamp and Lighting Co. Ltd., Publicity Department, 44 Fitzroy Road, London, N.W.1.

✻ If you don't have a copy of the I.E.S. Code yet, send 12/6 to: The Secretary, Illuminating Engineering Society, 32 Victoria Street, London, S.W.1.

If yours is "no ordinary" lighting problem

Well, we don't talk about "Lighting problems" ourselves, because a project is no longer a problem when you know the answer. But industrial lighting does often call for expert knowledge and experience, a particular knotty point may be similar to a job we tackled last week, or even if it is a new one the distillation of knowledge gained from experience of other challenges will enable us to advise you correctly.

Just a few fittings in the wide range of Simplex Lighting Equipment are shown here.

But we don't want just to sell you lighting fittings. We want to sell you light. The right amount of light in the right place at the right time. Therefore, we would be pleased to help or offer advice on any of your lighting problems — the type of fittings to use, the installation layout for best results etc. without obligation.

For immediate service there's a local Simplex branch near at hand — or write to Lighting Dept., at the head office address below.

SIMPLEX
PRODUCE LIGHTING
TAILORED TO
EVERY
REQUIREMENT
····INCLUDING
YOURS

Simplex Junior Reflecto-Flood. Designed and constructed specially for area floodlighting.
Simplex Dispersive Range of Weather-proof Reflectors for interior and exterior uses.
Simplex Bulkhead Fittings. A range of general purpose fittings of exceptional strength.
Simplex Screw-glass Fittings. This smart, modern range is all purpose and one of the most comprehensive.
The Simplex ACF (anti-corrosion fluorescent) Fittings are protected by a patented process that will not corrode even in the heaviest of industrial atmospheres.

Simplex

SIMPLEX ELECTRIC COMPANY LIMITED
CREDA WORKS, BLYTHE BRIDGE, STOKE-ON-TRENT, STAFFS.
Branches throughout Great Britain and Agents throughout the World

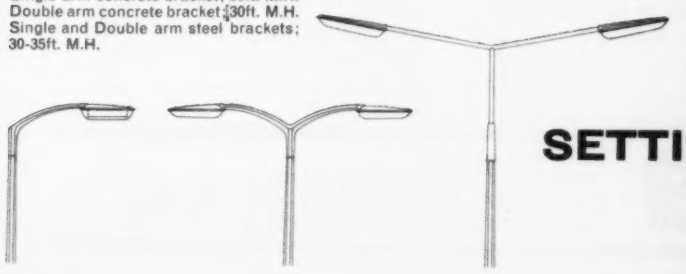
ELECTRICAL DIVISION *Detailed literature available on request*

Simplex Blended High-Bay Fittings for interior installation where a blend of mercury and tungsten light is required.

L.10

Photograph by courtesy of J. Woodhouse, D.P.A., Public Lighting Engineer, City of Sheffield.

The New Highway is available with:
Single arm concrete bracket; 30ft. M.H.
Double arm concrete bracket; 30ft. M.H.
Single and Double arm steel brackets; 30-35ft. M.H.



The New Highway column with tubular steel bracket for 35ft. mounting height has been chosen by the City of Sheffield for the new Parkway scheme; also by the Council of Industrial Design for inclusion in their South Bank Permanent Street Furniture Exhibition, as being one of the best designs available for high intensity street lighting requirements.

SETTING THE PACE IN STYLE

CONCRETE UTILITIES LTD.,
Head Office:—WARE, HERTS:
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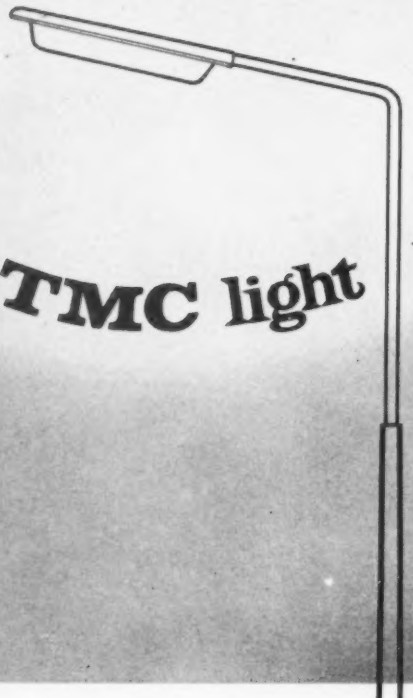
Works at:—WARE, LIVERPOOL, HIRWAUN, NEWCASTLE, COLEFORD (Glouces.)

What's NEW ?

in the TMC light programme

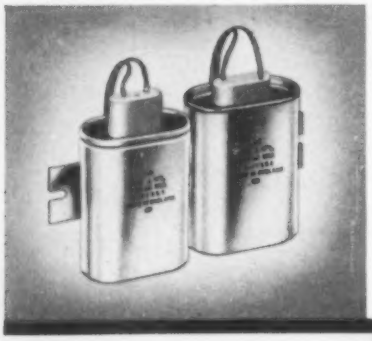


a range of STREET LIGHTING CAPACITORS to fit the new slimmer columns

TMC

These capacitors measure up to the most stringent performance needs and reinforce Mr. Capacitor's claim to being your most reliable capacitor man.

* Specially processed mineral and synthetic impregnants are used in association with low loss Kraft tissue and pure aluminium foil.
* Designed to meet modern requirements efficiently.
* Competitively priced.
* Supplied with fixing brackets (convenient for column or lantern mounting) or alternatively without brackets.



* 9" leads with shrouds are standard, can be supplied with alternative leads and without shrouds if required.
* Fitted with discharge resistor.
* Earthing terminal on bracket if required.
* Width of bracket slot $\frac{1}{4}$". Nominal fixing centres $3\frac{1}{4}$".

Power Factor Correction Capacitors
Street Lighting Types 275 V.A.C. Max.
Type OR (–40 to + 60°C.)
Welded Aluminium Cased, Elastomer Sealed

Capacitance (Standard Tolerance ± 10%)	Dims. in inches	
	Case Lengths	Cross Section
8 μF	$2\frac{1}{4}$	3 x 2
10 μF	$3\frac{1}{4}$	3 x 2
13 μF	$3\frac{1}{2}$	3 x 2
15 μF	$4\frac{1}{16}$	3 x 2
18 μF	$4\frac{1}{4}$	3 x 2
20 μF	$5\frac{1}{16}$	3 x 2

Type AR (–5 to + 60°C.)
Welded Aluminium Cased, Elastomer Sealed

8 μF	$2\frac{1}{4}$	3 x 2
10 μF	$2\frac{1}{4}$	3 x 2
13 μF	$3\frac{1}{4}$	3 x 2
15 μF	$3\frac{1}{4}$	3 x 2
18 μF	$3\frac{1}{2}$	3 x 2
20 μF	$4\frac{1}{4}$	3 x 2
25 μF	$4\frac{1}{4}$	3 x 2

Type HB (–25 to + 50°C.)
Aluminium Cased, Elastomer Sealed

8 μF	$2\frac{1}{2}$	$2\frac{1}{2}$ x $1\frac{1}{16}$
10 μF	$3\frac{1}{4}$	3 x 2
13 μF	$3\frac{1}{2}$	3 x 2
15 μF	$4\frac{1}{4}$	3 x 2
18 μF	$4\frac{1}{4}$	3 x 2
20 μF	$5\frac{1}{16}$	3 x 2
25 μF	$6\frac{1}{4}$	3 x 2

A MEMBER OF THE GEC GROUP OF COMPANIES

TMC

Further information from:
TELEPHONE MANUFACTURING COMPANY LIMITED
Capacitor Division · Sevenoaks Way · St. Mary Cray · Orpington · Kent
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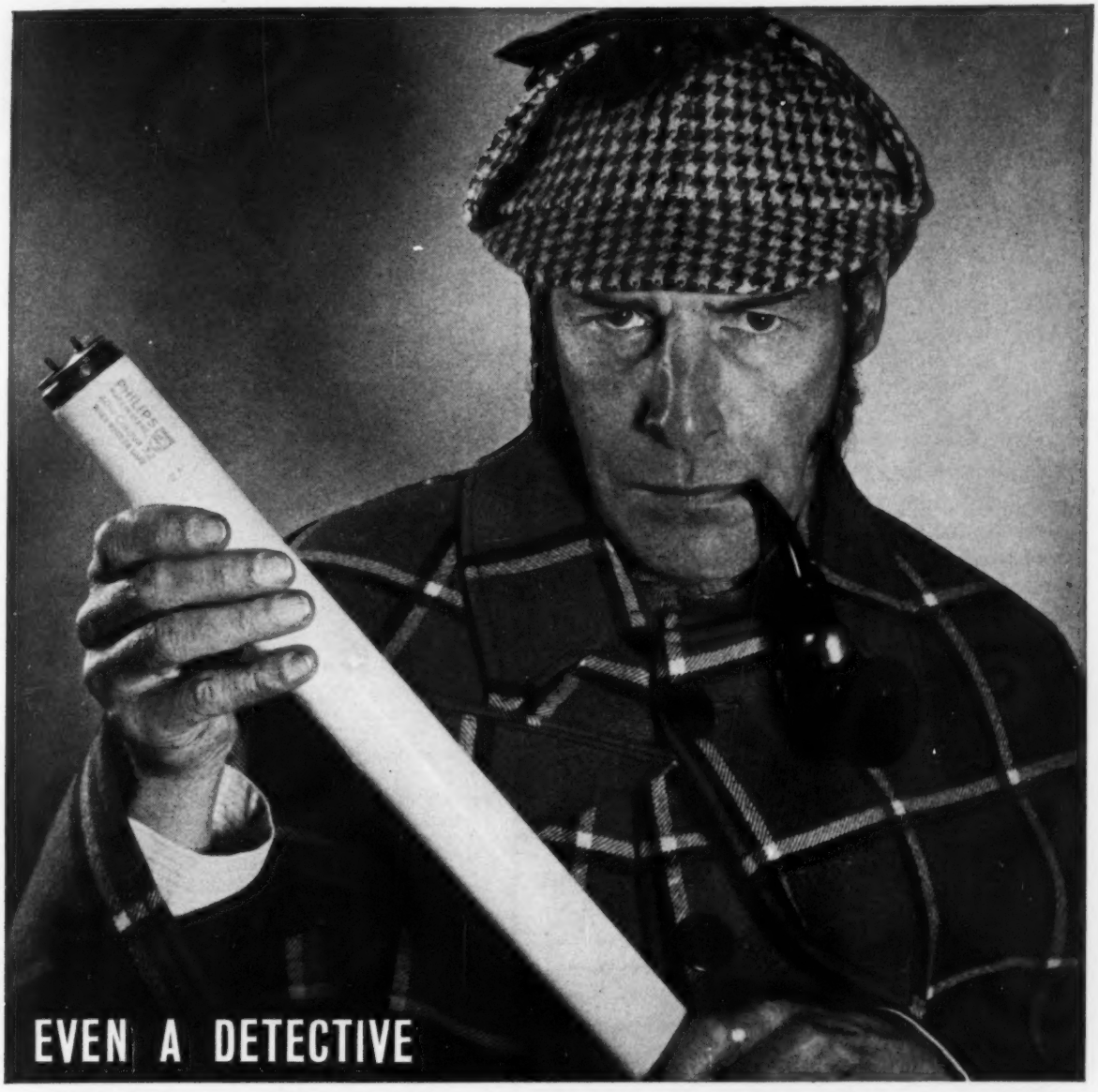

COULDN'T FIND ANY OTHER FLUORESCENT LAMPS WITH ALL THESE FIVE ADVANTAGES

You can search high and low but, wherever you look, you'll always find it's only Philips who offer fluorescent lamps with all five of these major advantages. So, for fluorescent that's far, far ahead, specify Philips!

1 De luxe lamps with double phosphor coating—Colour 32 the established choice for superb lighting of food, and the new Colour 34 for lighting clothes. Specify double-coated—they cost no more than single-coated de luxe.

2 Grain-size selected phosphors for maximum lumen output. Ultra modern machinery mills phosphor particles to the optimum size, rejects any that are not right. Hence the top luminous efficiency, maintained throughout the life of the lamp.

3 A special binder guards the electrode emissive coating and, together with high purity fill gases, ensures life that is getting longer and longer.

4 All standard lamps above have *both* silicone coating *and* earthing strip. 'Belt and braces' technique gives sure starting, means one stock type only for each and every fitting.

5 Fully closed anode ring (80W 5 ft.) reduces end-blackening and extend electrode life.

Once again

PHILIPS LEAD THE WORLD IN LIGHTING

PHILIPS ELECTRICAL LTD · LAMP & LIGHTING GROUP · CENTURY HOUSE · SHAFTESBURY AVENUE · LONDON WC2

(LD3300)

ALLOM HEFFER

AND COMPANY LIMITED

The 707 range of Recessed Modular Fittings incorporates all the refinements necessary for quick fixing and easy maintenance.

Pictorially are shown the salient points:

1 Finger tip fixing (quick fix catch Patent Application No. 39587/60).

2 Plug and socket connection.

3 Detachable and hinged gear trays.

4 A pull-push method of opening and shutting diffuser, which can be hinged and detached.
(Locking device—Patent application No. 32933/59).

Apply for leaflet Series 707

Barbour Index File No. 263

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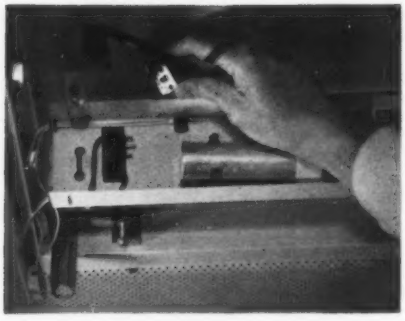

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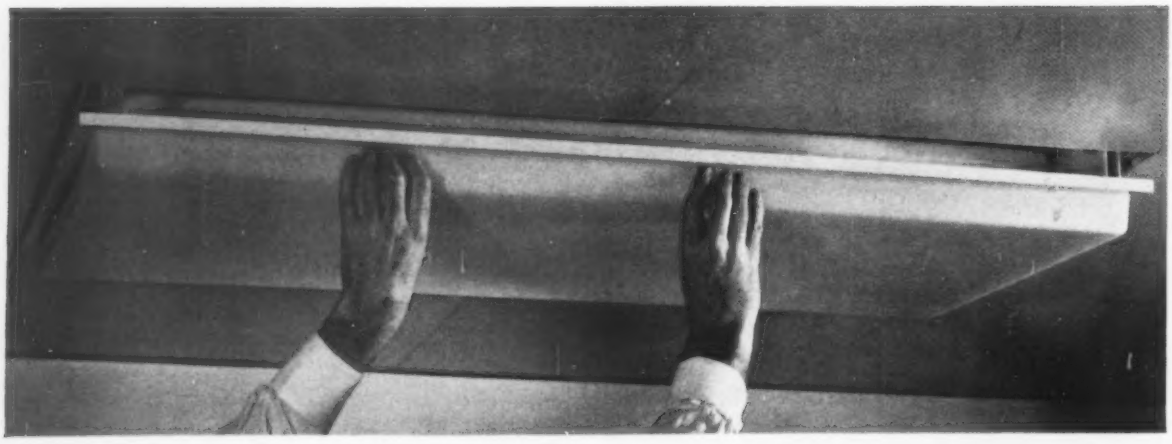

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Light and Lighting

Vol. 54 No. 10

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Published by the Illuminating Engineering Society at 32 Victoria Street, London, SW1 (ABBey 7553). Printed in England by the Shenval Press, Simson Shand Ltd, London, Hertford & Harlow. Annual subscription 2 gns.; single copies 3s. 6d.

Office lighting

A lot is being said and written at the moment on the subject of office lighting; no doubt even more will have been said and written before the current British Lighting Council campaign comes to an end. During recent years a fair amount of attention has been given to the subject; a number of papers and articles have been published, and a considerable amount of experience has been gained by lighting engineers and architects. The government itself drew attention to the state of office lighting as long ago as 1952 when Post War Building Study No. 30 was published, and we are now awaiting the introduction of legislation which we imagine will lay down minimum standards of quantity if not quality. Also during the post-war years the industry has produced more efficient lamps, better fittings and improved techniques for doing the job. The stage would therefore seem to be set for action rather than words. We cannot, however, expect a rapid change in the state of office lighting just because the industry has the know-how and the government cracks the whip. The problem of convincing the client of the value of good lighting is by no means solved. The most direct approach to the client to date is the Institute of Directors' Report 'Better Offices' but as will be seen from a discussion reported in this issue one of the difficulties faced by the compilers of the Report was to produce figures which would convince managements of the value of lighting in the context of office work. Prof. Page is of the opinion that an improvement in efficiency of only 2 or 3 per cent can justify expenditure on improved lighting. Lighting engineers are not unfamiliar with this argument—but the fact remains that the necessary facts and figures are not available in a sufficiently convincing form. Determining this relationship between lighting and efficiency is a task which, however difficult it may be, the industry can no longer afford to ignore.

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Notes and News

THE REPORT FOR LAST YEAR of the Illuminating Engineering Research Institute makes particularly interesting reading, in that it marks the 15th anniversary of the Institute's founding with a broad review of research activities rather than recordingly only the events of 1961. The report, therefore, is in three main sections: the first covers last year's activities; the second is the reviews (in tabular form) from 1945 to 1959 and in the last it details future commitments.

During 1960, the major effort was devoted to six specific areas of inquiry. One of these was a study by Mrs O. M. Blackwell of the lighting needs of sub-standard eyes; it first required the development of a new instrument—a recording discriminometer—by which the subject's visual acuity may be measured. It was then necessary to determine the reactions of different elements of the eyes to varying lighting levels, in order to isolate such elements in malfunctioning or degenerate eyes, using parallel responses of normal eyes as a control. It has been found that the acuity of vision in patients having only rods rises initially but then decreases as the illumination is increased. In other eyes having rods and some blue cones, a moderate increase in acuity was established, the extent of the increase being related to the number of cones. It seems reasonable to presume that when the reactions of various optical disease factors are known, it will be possible to prescribe an appropriate lighting formula for patients. Another current project has been examining visibility under street lighting and has shown that roads need to be illuminated to 'an average of 1·9 foot-candles' in order that motorists will see obstacles and stop their vehicles safely from a speed of 40 m.p.h. One of the results of this study was the development of a modified disability glare meter with which it was possible to measure the losses of contrast due to the disability glare normally experienced from street lighting systems. The work also showed that about twice as much light is needed in curbside traffic lanes as in driving lanes.

Reference is made to Dr Hopkinson's work on direct glare from large-area light sources, which he carried out at Cornell University on a 7 ft square source to supplement his work in Britain on a 4 ft square source. His report is still being prepared, but it seems that it will advise limitations on the brightnesses of large-area sources such as luminous ceilings and windows. A study of reflected glare in schools and offices, started by the late Benjamin Pritchard and continued by members of Dr Blackwell's research team, has come out with the suggestion that polarisation of the light can help in reducing the loss of contrast due to reflected glare. They also point to the value of a re-distribution of light which gives decreasing amounts in the potential glare zone and increasing amounts in the non-glare zone. Associated studies have been made of the loss of visual efficiency with the transistional adaptation which occurs when attention is transferred rapidly from a brightly-lit to a darkly-lit area. It was found that a 3 to 1 change in brightness resulted in a 15 per cent loss of contrast, which increased to 76 per cent with 10 to 1 change.

New work planned for the future includes further field task simulator studies. As may be known, the simulator comprises a 7 ft wheel on whose outer edge are mounted 50 translucent plastics discs each 4 in. diameter; in the previous work, observers were required to notice defects in the centres of some of the discs but the task is now to be made more difficult (and more truly representative of actual inspection conditions in industry) by locating the defects anywhere on the discs. It is also planned to study how the field factor (previously set at 15) and the rate of assimilations per second (previously 5) may vary to determine whether they vary for different tasks and conditions in practice.

Research Symposium

MORE DETAILED ACCOUNTS of most of the work being carried out under the aegis of the IERI is contained in the Proceeding of the Third Research Symposium held in Washington in March of last year, and now issued by the Institute. The document gives the eleven papers presented at the symposium, ranging from pleasantness in colours to visibility in fog.

Road Research in 1960

STREETLIGHTING OCCUPIES a comparatively small part of the Road Research Laboratory's report for 1960, published recently by HMSO, but is not without its significance. Particularly notable, in the Research Board's section, is the admission of a gap in the Laboratory's knowledge in the effect of lighting motorways. Whilst the Board does not repeat its recommendation a year ago that motorway intersections should be lighted, it still points to the need for study, by means of an experimental installation, of the effect of lighting on accident rates and driving comfort on motorways. This is a need which has been emphasized by streetlighting and other experts for some time now, and was pointed out by us as recently as March of this year, in condemning the Government's decision not to undertake any form of

motorway lighting. Turning to the more detailed section of the report, mention is made of a survey carried out of the luminance of illuminated road signs using a telephotometer. Nearly all the signs surveyed had an average luminance less than that recommended in the relevant standard BS 873 and the brightness of some recently erected large advance warning signs was particularly low. Another aspect being studied is the legibility at night of unlighted signs. These are usually turned in slightly towards oncoming traffic and specular reflection of cars' headlights therefore impair their legibility. It has been found that specular reflection can be prevented, within the legibility range, if the signs are turned through a small angle away from traffic rather than towards it. The angle of turn need be no more than 5° and can be as little as 2–3° for motorway signs. Most people will recall the controversy flashing pedestrian crossing lights and car direction indicators aroused; many critics felt that the flashing would prove distracting and misleading. Past work by the Laboratory has shown, however, that against a background of a number of different light sources of different size and colour, the most readily seen signal was a flashing light. This conclusion has now been modified by more recent studies involving a field of view containing a variety of sources of which more than one is flashing. It was found that the advantage of making the signal flash was lost even if only one light in the background was also flashing; it was a positive disadvantage to have the signal flashing if there were three irrelevant lights flashing in the background and a serious hindrance if more than four flashed.

Manchester's Building Centre

TO JUDGE FROM its first report, the Manchester Building Centre, which opened just over a year ago, has become a very lusty infant and is soon to be more than twice its present size although it will not have grown to full size until mid-1963, when the remainder of the building it occupies will become available for its use; this will increase its occupation space from 12,000 to 31,000 ft² and it will then be able to offer office and meeting room accommodation on a much larger scale. Even now, several organisations and firms associated with the architectural and building industries are using the centre for meetings. A special feature is a lecture room accommodating 105 people, equipped with 36 projectors of various kinds for special lighting effects during exhibitions and with dimmer-controlled wall and ceiling lighting. The permanent exhibition has already proved its value and the number of firms exhibiting has increased from 160 at the opening to more than 200. More than 13,000 visitors were recorded in the first six months of the Centre's life and the rate is now well over 1,000 each week. The Centre maintains a comprehensive information service, which includes a telephone answering and inquiry recording system operating after office hours.

Fittings Data

WITH THE PUBLICATION by the IES of its new Code now supplemented by the Technical Report No. 2, many lighting manufacturers will have been re-examining their lighting fittings in the light of the BZ classification. Already AEI has produced a series of light performance data sheets giving this information for 74 fittings for commercial and industrial application and of the module or recessed types. The data include the BZ classification, the upward, downward and total light output ratios, flux fractions and luminous area together with a table which gives values of direct ratio for room indexes ranging from 0·6 to 5·0; there are two values of room index given in each case, one for spacing/working-height ratios of 1:1, the other for the recommended maximum spacing/working-height ratio.

High-power lighting for offices

WITH OFFICE LIGHTING very much to the forefront at the present time, it is particularly interesting to note the studies which have been carried out to determine just how much light office workers like to have. Following the BLC's brief experiment at up to 350 lm/ft² at Brettenham House, Atlas have extended their particular study to Thorn House, where a working area of 320 ft² has recently been provided with an installation capable of establishing an illumination of 500 lm/ft², using 135, 8 ft 125w lamps spaced at 3 in. intervals above a ½ in. mesh louver within a 10 in. void. The installation can be switched in three steps each of about 170 lm/ft² but for day-to-day working, the first step only has been used so far; heating and specular reflections have been contained within acceptable limits. Studies by the firm's Lighting Development Group, in association with their consultant Mr H. C. Weston, are continuing.

by courtesy of 'Interior Design and Contract Furnishing'.

This area on the executive floor of a new five-storey office block, designed by E. H. Willison, LRIBA, at the headquarters of Ilford Ltd, provides a good example of a well-planned office interior, in which the light coloured furniture and décor assists in giving an adequately, but not excessively, variable brightness pattern.

OFFICE LIGHTING

A discussion between J. H. Gura, AMIEE, electrical consultant, L. H. Hubble, lighting engineer, Maurice Jay, Editor of 'Interior Design and Contract Furnishing', J. K. Page, MA, Professor of Building Science, Sheffield University, Andrew Renton, FRIBA, FRIAS, architect in private practice, and H. B. Wright, MB, FRCS, Director of the Medical Research Unit of the Institute of Directors. The Chairman was G. F. Cole, Editor of 'Light and Lighting', who defines the scope of the discussion in his opening remarks.

Chairman Well, gentlemen, we have met to discuss the lighting of general offices—not the executive type of office but those in which so many people spend much of their working lives. There is a growing awareness of the importance of good working conditions in offices and also of the contribution which lighting can make. There are, however, a number of questions which need to be answered and though we cannot hope to deal with all of them today perhaps can at least give one or two pointers.

Each of you has some specialised knowledge of offices and each of you has studied to a greater or lesser degree the question of lighting—at least you have all had something to say about office lighting at one time or another. Out of our discussion I should like to get some ideas on how lighting can be used to promote efficiency in offices, how lighting engineers and architects should collaborate, and how clients might be educated in the value of good lighting.

To start you off may I attempt to define the purpose of lighting in offices as being to enable people to work in them, to do their jobs efficiently and, as far as possible, in comfort and without avoidable strain during the whole of the working day and at all times of the year.

Wright How do you define factors like 'efficiency', 'comfort' and 'avoidable strain'?

Chairman Well, how do you?

Jay There is no way of measuring output in an office as you can in a factory to produce a direct relationship between the surroundings and the results, but there are things that are important in relating office conditions to efficiency. First, there is the type of staff you attract. You interview girls for a job. If you have a dirty, dingy office, the best ones turn the job down and you are left with the choice of the inferior ones. Then there is staff turnover. There is no doubt that you keep staff longer if you have a good office . . .

Wright How do you substantiate that?

Jay I know firms that can give reliable figures of their staff turnover.

Wright But there are an equal number of firms who may have people working for them year after year in dingy basements just because they love the boss. It is not as simple as that. This is the sixty-four-dollar question in all these matters.

Jay If you have a very bad boss and the wages are low you may still keep staff when you have good offices, but if you have a bad boss and bad wages *and* the office is bad, then the firm has had it. It is only one factor, I know, but I have seen figures for firms with extremely low staff turnover, and they were all firms with extremely good offices.

Hubble The obvious is always the most difficult thing to prove; so don't let us try to prove it. Amenities, comfort, the pleasure of entering an office in the morning, the willingness to stay there, the enjoyment of the job—all these things depend on the lighting as much as anything else, and probably more than on most things.

Gura I cannot entirely agree with that. It is perfectly true if we are discussing the difference between 3 and 15 lm/ft², but we are talking of differences between 15 and 50 lm/ft² or more. Thousands of offices are being put up where levels of illumination of 30–50 lm/ft² are being put in, and some people are beginning to wonder whether, in solving one problem we are not creating another. It is necessary to produce to the public, if not precise information, at least information that is more than just the obvious.

Hubble What do you mean by solving one problem by creating another?

Gura The heating effect of lighting installations is beginning to get serious. An efficient 50 lm/ft² installation represents 3 watts per square foot, and if you have, say, a modern office block where there are high solar gains and conditions leading to heavy occupancy you already have a problem of cooling. Adding a further 3 watts per square foot for the lighting increases the problem. Roughly speaking, for every kilowatt of lighting within the region where you already need cooling there will be about £100 capital cost to get rid of the heat. In addition to the running costs of the kilowatt of lighting you will have a further running cost of ½-horse-power . . .

Hubble Are you talking of the tropics?

Gura No, we have these conditions in *this* country. In some of the high buildings in London, with their open views of the sky, solar gains and supplementary artificial lighting are creating serious air-conditioning problems.

Chairman This is a very particular problem. . . .

Gura Yes, but the fact is that lighting can create engineering difficulties. . . .

Chairman The levels of illumination, you mean?

Gura Yes.

Chairman Then let us discuss levels of illumination.

Wright Hubble said that we do not need to prove the obvious, but it is not quite as simple as he says. It you are trying to sell higher standards to a hard-headed client you have to show how it pays off. The other side of the penny with regard to offices is that, on the whole, people resent change, and very often improving conditions, particularly if morale is already bad in an organisation, can create more problems than it solves.

Renton You say let us have higher illumination standards and better lighting, which involve extra cooling and the attendant service problems, but we, the architects, have to sell the idea to the client.

Hubble I do not necessarily mean *much* higher levels of illumination; there is a lot more to the question of good lighting, such as getting the best out of existing levels.

Chairman There is, nevertheless, a trend towards higher levels; do you consider this desirable, and where is it leading us?

Page When we came to write the Institute of Directors' Report 'Better Offices', one of the difficulties I faced was to produce figures which would convince managements of the value of lighting in the context of office work. While you can get to a lot of

From left to right: Andrew Renton, J. M. Gura and Maurice Jay.

figures relating to the making of clay tiles, and to various other industrial activities, it seems that lighting performance in offices has never been studied in detail. It may be just an omission in my knowledge, but I really do not think the information is there. I think this is partly related to the difficulty of defining the office task, and the general problem of measuring production in the office situation. It may be possible to do it in terms of typing mistakes, or something like that, but it is a study that remains to be done. . . .

Chairman And one that ought to be done. . . .

Page And it would certainly be of great value to the lighting industry if it *could* be done.

Secondly, we have to bring in cost right at the beginning, and it is very important to recognise what increased levels of illumination will pay off in terms of increased efficiency. There is a tendency to think of lighting costs as being very much higher than they are; and I would have thought that in many instances even a small improvement in efficiency—2 per cent or 3 per cent—would justify expenditure on improved lighting, but, of course, I have no facts on this subject, and I am not sure that they exist.

Wright A great deal of work has been done in trying to measure efficiency in clerical work, and to measure specifically the contribution made by the physical environment in terms of heating, lighting and ventilation, and it nearly always comes unstuck on the difficulty of measuring morale and motivation. If people are unhappy at their work it does not matter how good the conditions are, whereas if they are happy and supervision is good, they will still do good work and give good output even if the conditions are poor. One must not over-simplify this problem.

Hubble It isn't true that there hasn't been any work done on illumination levels; there has been quite a lot and it is crystallised in the new IES Code. The kind of subjective tests about which Wright talks are so full of extraneous influences that the results, if any, would be extremely inconclusive. And I must say I deplore this emphasis on economics; after all, light now costs less than one two-hundredth of what it did fifty years ago.

Page I am sorry you deplore it, because this is at the bottom of the lighting problem. I believe very strongly that in the final analysis lighting standards are determined by a combination of two factors: a knowledge of the effect of light on human performance from the physiological point of view, and the economic resources which enable one to get closer or further away from what one's knowledge indicates is necessary. I certainly think that it would be quite unrealistic to say that people do not consider the economic factor. In fact, I think that the main difference between American and English lighting practice can be accounted for entirely in terms of relative costs—the relation between the cost of light and the cost of labour. So I don't think you can discuss standards of lighting without bringing in economic factors. . . .

Renton *and* human factors.

Jay Could I ask Professor Page and Dr Wright particularly one question: if economic factors are so important why is it that many firms building offices today are prepared to exceed by quite a long way the new IES standards, and were exceeding them even before the new Code was published?

Gura Part of the answer—and this is perhaps the anchor point—is this: We accept the IES Code as being sound, but the one factor that is greatly influencing levels of illumination is daylighting levels. Here is something, from the lighting engineers' point of view, that is definite. The building is produced for him. It has a definite daylighting level. Whether it is right or wrong, it is an established fact in a building when it is designed, and it poses the biggest single problem because, quite clearly, while one would be entirely happy with 15 lm/ft² in an old Victorian building with a low daylight factor, in a new building with a daylight factor of ten times that, where you are working for some hours at 150–200 lm/ft², artificial lighting at 15 lm/ft² looks entirely different. This is what is forcing us away from the IES Code, which is completely realistic when one considers artificial lighting in isolation.

Chairman I must point out that the IES Code includes quite a lot on the subject of permanent supplementary artificial lighting.

Jay Another element comes into it. There is the office girl who goes into the stores during the lunch hour where there are fantastic illumination levels. . . .

Page What are 'fantastic illumination levels'?

Jay Fantastic compared with the IES recommendations for offices. She comes back to her office, and if that is not lit to something comparable she will find it very dismal indeed. That is another extraneous factor.

Wright There are two relevant points here. First, as you imply, it is quite unrealistic to separate artificially these various factors, because they are all linked together. You cannot consider heating, lighting or any other service in a vacuum.

Secondly, in terms of economics, in considering lighting, or noise control or anything else, you are stating the case for your slice of the cake to the client. There is a certain total sum to be spent on the building and what you are really deciding is how to cut up the cake. Economics, then, are very important because the client's total sum is usually more or less fixed, and you have to help him to decide how he can best deploy it. Is it better to spend more on extra lighting—or on the lavatories or lifts?

Renton Over a period of ten years it is perfectly true that the costs of services—heating, ventilation and lighting, etc.—have gone up remarkably, but the ideas of the client in his spending have not matched that rise. It is therefore becoming increasingly difficult for the architect to persuade his client to have quality in his building as well as quality in the services going into it.

Chairman What about the proportion spent of lighting? Has this gone up?

Gura Oh, yes; it has gone up considerably in the last few years. If one takes an average office block, costing say 85*s*. a

square foot, one may be spending about 7*s*. 6*d*. a square foot on good lighting today, whereas five years ago it might have been only 2*s*. 6*d*. The change is as radical as that.

Chairman Can we now get to some of the details in connection with office lighting? We have spoken of illumination levels, but that is only part of the story. Perhaps we could agree that there is a need for further field studies before we can say that much higher levels of illumination are justified.

Page Well, I myself am convinced of the value of higher levels of illumination than those in the Code. The principal difficulty is to find the direct evidence for convincing managements. If one has a good background of knowledge about research into lighting performance, one is convinced in the absence of empirical field studies, but it is much more difficult to make out a case for the layman.

Hubble Before we leave this question of illumination levels I would like to add one point. So far we have been talking about lighting as though it were purely *artificial* lighting. In my view, no architect, no consulting engineer, indeed nobody concerned in this matter at all can get away from the concept of the total lighting of a building. Lighting has to be a composite effort of daylight (while it lasts or where it penetrates) and artificial lighting (when required and where it fills up). The integration of daylight and artificial light is a 'must' from now on. They cannot be considered separately. To me, something around 35 lm/ft² is adequate lighting for any reasonable office task.

Page The Americans would not agree with this, but I do agree that it is important to bear in mind the difference between daylight and artificial light, in that the efficiency of the former is about a hundred lumens per watt. Thus, you can only achieve balance between daylight and artificial light at the expense of much greater heat from the artificial lighting than you get from the daylight. That is one of the important limiting factors we must certainly bear in mind in this discussion.

Wright The other point is that, whatever one may believe is desirable, you have to make it acceptable to the ordinary man. You expect a person to work in the middle of a building—out of contact with the outside world. You may give him environmental conditions which, to you, seem as good as those outside, but you have to make these conditions acceptable to the office worker and the cost of providing them acceptable to the client.

Renton In other words, it is not enough for the consultant to say, 'This is the appropriate level of illumination,' if, for example, it is extremely dull because of lack of variation.

Chairman That brings us nicely to the point where we might consider other factors that make up the environment in which people work. A number of things come into this, such as the direction of the flow of light, glare from fittings, and the general brightness of the surroundings.

Page I feel that one of the subjects in which the British lighting industry has not shown enough interest is the general question of the rendering of form; the nature of shadows—modelling. You notice this very much in modern shop-lighting practice. The interior always seem to be 'flushed out' with light, as it were, and nothing seems to be seen three dimensionally. This is a problem of which the architect is aware but he suffers from a lack of technical knowledge to deal with it, while many of those with the technical knowledge do not seem to be aware of the problem.

Renton But, surely, the architect should be competent enough to assess the effect he wants and then ask the expert: 'How can I achieve this effect?'

Chairman Is 'modelling' not a rather artistic term to use in connection with office buildings?

Page Perception of form is, perhaps, a better term.

Chairman What sort of form are you trying to reveal?

Page It may be the three-dimensional keyboard of an unfamiliar computing machine.

Chairman Unfamiliar?

Page It is, at the beginning. The three-dimensional perception of form is an aspect of lighting which is very important. Quite clearly, it is related to the illumination of vertical surfaces and the ratio of lighting from different directions. Certainly, one of the characteristics of many contemporary lighting systems is that shadows are confined to the underside of the object and there is very little shadow around the sides of it.

Chairman Apart from the particular case of the calculating machine, which I should have thought rather specialised, I cannot see the importance of this three-dimensional modelling in an office block.

Renton One must try to reproduce indoors the modelling one is accustomed to seeing out of doors.

Gura One is always being asked by people like Mr Renton for lighting which gives form and shape and depth and so on; one can always provide it, but only as a difficult solution to a very difficult problem. If we are lighting a museum or some sculpture, we know how to light it and give it form, but here we are discussing the problem of everyday offices. The very thing that we are trying to blot out is the directional light. We have daylight coming in at one side, and we are told right at the beginning that the object of augmenting daylight is to counteract this. . . .

Jay You want to eliminate the contrast between the daylight and the artificial light. . . .

Hubble Supplementary artificial lighting isn't intended to blot out modelling, but to augment the level of illumination and overcome sky glare. Anyway it's a slight on the illuminating professional to say we don't think of modelling. Indeed, we've given it quite a lot of thought, but I would say that unless people in offices are all permanently located in one place and orientated in one direction, modelling is something we must, very reluctantly, abandon.

Renton I'm not asking for 100 per cent sculptural modelling, nor is Page.

Wright What you mean by modelling is what I mean by acceptability. Does the form of things resemble its appearance out of doors? This has much bearing on whether people will be happy working eight hours in these conditions.

Hubble What do you mean by what it looks like out of doors?

Renton Seeing it standing in daylight, so that you can recognise its form by the light, shade and shadow around it. You have, for example, a cube, but if you take this cube into what Page calls the interior flushed out with light, instead of being a cube it becomes a flat shape.

Hubble What about the 'flushed-out' English weather? I agree with you entirely when it comes to the tropics—as I agreed with Gura, too. But how often do we get strongly directional sunlight in this country?

Page May I come back to my remarks on the lighting profession? I know of the work being done in this field, but I would have said that those who are designing lighting fittings for typical offices at the moment do not really take the question of shadowing into serious consideration. One of the big difficulties with artificial lighting is that you do not have a parallel beam source of light but a number of independent sources of light producing a whole series of shadows. This difficulty is more important than many people realise and deserves more study.

Hubble I quite agree.

Jay Accepting the present stage of development of the science of lighting, I think you have to create interest in a room, or make it acceptable, in other ways. In other words, you have to accept the limitations of fairly even illumination, but you can, for example, use colour to prevent monotony. When illumination was more difficult to provide, in terms of costs and levels—before fluorescent lamps and so on—designers of office interiors were obsessed with colours that would reflect the light and not absorb it, because you could not afford to waste any. But now that high levels can be obtained more economically there is a case for using colour more imaginatively—using richer colours—because you need not worry about the reflection factor so much.

Chairman Another aspect of outdoor lighting is that it is changing all the time, while maintaining a very high illumination. Is it not possible to make our indoor lighting more attractive by varying illumina-

tion levels, as well as using colour more imaginatively?

Gura This is a very complicated question. We are saying, in effect, that we are producing for ourselves an artificial environment which is quite different in many ways from our natural environment. Is it logical, therefore, to endeavour to retain what we can from the natural environment, or to produce artificially conditions which as nearly as possible resemble the natural environment?

Hubble Can we draw such a hard-and-fast line between artificial and natural? While we have windows, we have to some extent a natural environment.

Page Any building is an artificial environment, by definition. I believe that all environments in buildings are artificial as compared with the natural environment outside. But to come back to colour, it is important to remember the problem of glare. We can always raise the illumination by using lighter colours, but there are also techniques for bringing the illumination up to acceptable levels even with low reflectivity. These are long-standing architectural techniques that we could well bear in mind in office lighting—the use of high-lights, and points of emphasis, and emphasis of colour, and so on.

Chairman On this question of glare, while direct glare from fittings is receiving much attention, reflected glare from room surfaces and work surfaces is somewhat neglected.

Page The big problem in this connection is to persuade people to accept furniture of

Professor J. K. Page.

a lighter colour than in the past. There are two difficulties here. People already have furniture and are not keen on throwing it away. Secondly, I am not quite sure why this tradition exists but, certainly, Englishmen are very fond of dark-stained woods. If they get a nice piece of light wood they at once put on a dark varnish. I don't think the furniture industry—or many architects for that matter—is aware of the importance of reflectivity in furniture design. They have an awareness of texture, richness and a feeling for timber and so on, but they don't really see the connection between the colour of the surface and lighting. I always teach architects to treat colour and lighting in a completely integrated way, but I think that this is exceptional at present. . . .

Renton I think perhaps you are underestimating the architectural profession.

Page Obviously, a lot of your profession are aware of this, but you must agree that there are many who favour very dark colours. . . .

Renton And a good many clients also.

Page The dirt problem also comes into it. I live in Sheffield, and the dirt problem there is very real indeed. We suffer more from dirt in this country than they do in most, and consequently there is a natural resistance to changing to light colours.

Hubble You cannot have dark walls just because they don't show the dirt. But I don't think we want to be too pessimistic about this. A few men who rather pride themselves on having achieved director status like to have dark oak panelling around them, but the ordinary man who takes his directorship in his stride probably already has light-coloured furniture.

Wright I don't think the director matters a damn—he is a highly-motivated individual. We are concerned here with the average chap in the average office.

Jay This battle for lighter furniture is half won already. You have only to look at the present ranges of office furniture—particularly of the metal furniture people, but the wood people are coming round too.

Hubble I agree. I think we are preaching to the converted.

Wright The big problem is existing furniture. If a client has spent half his money on improving his office building he doesn't want to throw away 250 desks; he hasn't the money, and the desks still have a lot of life in them. A lot of new buildings have been spoilt by having old furniture moved into them. The owners of an office building now going up in London have said, 'It will cost up £1½ million to re-equip this building with brand new furniture'. There is a big sales job to be done here. . . .

Chairman We seem to be doing a very good selling job for the manufacturers of office furniture ourselves, but let us come back to glare. I should like some views on the importance of direct glare from fittings.

Page It is perhaps the most important problem in lighting engineering design today, and one reason why I welcome the new Code so much is that it deals specifically with this problem. One of the techniques of competitive tendering in illumination engineering design has undoubtedly been that while meeting the illumination standards, lower costs have often been achieved by putting in installations with a high glare index. One of the great advantages of the new Code, from the point of view of the consumer, is that the client can now specify a glare standard, and all the people competing for the job are forced to design to approximately the same standards for glare. I have noticed that a

Dr H. B. Wright and Professor Page.

good many of the conscientious firms have taken a lot of trouble over their lighting installations but when it comes to the question of the lowest tender they are pipped at the post by someone putting in a poorly-designed installation—the right amount of light, but absolutely awful from the glare goint of view. When we remember how much building goes on in the public sector, and how much is on competitive tendering, to have a figure controlling glare as well as illumination seems to be one of the greatest advances in lighting practice this century.

Renton I fully agree.

Hubble That was a splendid exposition, Page. I don't think that anyone could add to what you have said.

Chairman I should like to know how far the *architect* considers the reflection factors of surfaces at the design stage, and how far he takes into account the effect the lighting will have.

Renton Artificial lighting?

Chairman Yes, artificial lighting—and the effect of the colour of the lamps he puts in.

Renton For the purpose of this discussion, the architect probably looks at the building almost as a piece of sculpture. The important factor is to achieve a subtlety of contrast as, in fact, the Code sets out. You enter the foyer, which is brilliantly lit. You escape from the lift into the light of the corridors, which is of average intensity, and you go into the work space which is at a higher intensity to achieve good working conditions. Reflection and so on is kept very much in mind in the selection of materials. The architect is all the time conscious of the human reaction—which is Page's point, too.

Page I agree with everything you say, but I would only stress the danger of overdesign. There is a tendency on the part of some architects to believe that a building will always be used in the same way and decorated in the same way. In the initial stages, one should give some consideration to the problem of possible changes that the client might introduce later.

Renton Adaptability of the building?

Page Adaptability of the scheme so far as colour and so on is concerned.

Renton In a recent office building we designed, the general floors were in a mid-grey finish, but some of the partitions, which were demountable, were given colour so that, irrespective of their arrangement, there will always be contrast between the negative 'envelope' and the colour of the partitions—to give acceptability, as Wright puts it.

Hubble When he has decided on the reflection factor he needs, can an architect not say 'it does not matter about the colour or the tint of the wall when it is redecorated, so long as the reflectivity is not less than 55 per cent or 60 per cent' or whatever it is he has specified?

Jay Would the directors of a company accept such a proviso? I know that some egocentric architects will not allow redecorations until they are consulted, but would the average director accept that sort of instruction from the average architect?

Renton No. You can only rely on the client's goodwill—you cannot demand it. At the end of every job we always hand to the client a colour scheme reference book so that he can order the same colours when he redecorates. . . .

Hubble With alternatives, I hope. You can get so tired of the same colour scheme.

Renton To give alternatives would be reasonable, of course.

Page If the client realises the importance of colour he will take professional advice when he redecorates. If we continue, as very many do, to look upon colour as independent from lighting we are bound to run into this kind of trouble. The fact is that clients need educating in these matters.

Chairman One can see that it may be possible to at least give some guidance on future colour schemes in big buildings—but how about the smaller jobs or offices occupied by tenants?

Page I do not think that the public is aware of the connection between colour and lighting. If you stopped a hundred people outside and asked them about it, I doubt whether you would find more than two who were consciously aware that there is a connection.

Gura Both Hubble and I have designed innumerable lighting schemes but in how many, Hubble, have you known what the decoration scheme was to be?

Hubble Not many.

Gura That is my experience; we work on architect's plans but seldom is he prepared to talk in terms of colours or finishes at the early design stage.

Renton That is often the case—but some architects *are* prepared to give you the information you need.

Gura I don't think I have had a single job where this information was forthcoming at the time we were expected to start designing the lighting.

Renton But have you ever asked the question?

Gura In some cases, I have.

Hubble What we have to do is to assume reflection factors for the ceilings, walls and floors respectively, and hope the architect's colours will not conflict with them. We say 'ceiling, seventy-five' or whatever it is, and if it turns out to be a white ceiling we are all right, but if the architect specifies a black ceiling, we are in a mess.

Gura That is the problem. We are talking of a situation in which three or four years may elapse between making a fundamental decision and the paint being applied.

Page So we come back to the fundamental problem of education. My experience in two schools of architecture has been that past methods of teaching lighting were most unsatisfactory. I do not think it is the architect's job to be able to design lighting systems, but it *is* his job to know what the architectural problems are and, clearly, colour is part of the architectural end of lighting. I am tackling this problem at the under-graduate level, but it should also be tackled at the professional level. There are far too few architects who really know about contemporary ideas on this subject. Many choose fittings unlit. They go to an exhibition, see something they like as a piece of sculpture and go off and order it.

L. H. Hubble.

Gura That's where the lighting engineer comes in. For years, what we have really been doing, in our quiet way, is determining glare control by assuming certain reflection factors and when the architect gets around to selecting his colours we discuss them with him in the light of our assumptions. One does not let the thing get out of control. As has already been said, architects don't all seem to appreciate the problem. It's not always easy for them to give us the information in time but on the other hand it is not all that difficult for them to give us *some* guidance at an early stage. True, they have a lot of things on their minds in the early stages of planning a building and they can't solve all their problems at once. There has to be an order of priority; unfortunately, however, colour schemes and finishes are often low on the list.

Chairman It would seem that both lighting engineers and architects must share the blame for this state of affairs. However, having designed the perfect installation it is no good unless the client looks after it—he has to be educated in maintenance.

Wright This brings us back to what Jay was saying. We all have a job to do in establishing the relationship with the client, the end result of which is that he is so impressed with what you have done for him that he listens to you, and will remember that what you say is sense, so that when you tell him, 'When you repaint this, for Heaven's sake do not do so-and-so, and if you want good service, put in good maintenance', he will pay attention.

Renton You may be interested to know that as a firm we are now producing a manual for each building we design and as we hand over the building, just as we hand over the colour scheme, we say, 'Your floors, your lighting, your furniture and finishes—this is the way they should be maintained.' Just as when you buy a new car you get a manual of instructions, so, with a new building, you should get a maintenance manual.

Wright To some extent, you want to establish a continuing relationship. You would like to be consulted in two or five years' time.

Gura This is probably the most difficult problem of all. One installs things like luminous ceilings and so on, which need a lot of regular physical work to maintain them—never mind repainting. Some jobs have to be done once a month; some, four times a year; some, annually. It costs money, and it applies to every part of the installation, and it applies to alterations and additions. It is very rare to go back to a building after a number of years and feel reasonably satisfied that the building has been altered, added to and maintained to the standard to which it was designed.

Renton But we have made a step in the right direction. . . .

Gura And a very good step.

Wright The crux of the matter is education. We are all interested in improving standards. The human animal, although very adaptable, is a very conservative animal. He tends to like what he has and to be suspicious of what he does not know about. We have a major job to do in leading him by the nose in the direction of something new. If you get him to the water he will soon start to drink.

Chairman We have covered a lot of ground and though there are no doubt many points we have not touched on I must now draw the discussion to a close. I am grateful to you for taking part and for introducing some stimulating thoughts on this subject. Readers may not agree with all you have said—in which case I hope they will continue the discussion in our correspondence column.

OFFICE LIGHTING

The changing scene

By W. ROBINSON, AMIEE, FIES

THE LIGHTING OF OFFICES is important to the well-being of many people who are affected perhaps more than they know by its quantity and quality. The present keen interest in legislation governing working conditions in offices is indicative of a somewhat belated appreciation of the special dependence of office workers on environment—for nowhere but in offices are people expected to remain static for several hours a day while constantly using their eyes and minds and to be as alert at the end as at the beginning of the day.

It is remarkable that in these circumstances so little published guidance is available on office lighting but it is certain that the new concepts introduced by the 1961 IES Code will initiate action to remedy this deficiency.

In the present state of the art, offices tend to be lighted simply as spaces occupied by office furniture and clerical workers, with little regard to the special visual problems involved. There are several factors which tend to perpetuate this state of affairs. In the first place the freeholder or developer is seldom the user of the office space; he has to make wiring provision for lighting without knowing much about the use to be made of the premises. Architects are faced with the same problem, aggravated by the fact that even the allocation of space within an office floor is seldom fixed in advance. The office tenants are faced with the necessity of obtaining lighting equipment for premises which may have a short, or uncertain, lease and must make the best of the lighting points provided. In the face of these difficulties it would be wrong to attribute the deficiencies of present day office lighting wholly either to technical failure, indifference or parsimony but nevertheless considerable improvement can and should be made both to technology and practice.

The 1961 IES Code clearly points the way to better office lighting with its new approach to illumination levels, glare control and the co-ordination of daylighting and electric lighting.

The IES Glare Index System represents a complete departure from the past treatment of glare. Its effect on office lighting will be greater than in most other fields since, for reasons already stated, office lighting tends to be backward by any standard. Furthermore the special circumstances of office work have been recognised by the adoption of a lower permissible Glare Index value (19) than is permitted for most industrial occupations (22–28). The necessity of this became clear during the many glare surveys that were carried out in the course of evolving the Glare Index System.

It further became evident that the widespread use of diffusing fittings in medium to large offices has introduced glare problems which previously had not been fully appreciated. There has thus grown up a 'tradition' of office lighting employing lighting fittings which are good in themselves and are chosen because they look better than their fellow industrial fittings, but which cannot meet the IES Glare Index limits in many situations. One major remedy could be applied forthwith to many existing installations, namely to re-orientate fluorescent diffusing fittings where they now run at right angles to the long wall of a relatively narrow room. Simple inspection

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The interior on the left illustrates the usefulness of perimeter lighting from fittings immediately over the windows. On the facing page, the top and middle pictures indicate that permanent supplementary artificial lighting is the key to the co-ordination of natural and artificial lighting achieved here and, of course, in many other interiors such as this. The lower picture shows the importance of the correct orientation of fluorescent fittings; had the fittings been aligned across the room, the glare discomfort would have been noticeably greater.

of the IES Glare Index tables shows that in bad cases this simple expedient can reduce the glare index by as much as 5 units.

Future trends in office lighting will undoubtedly be influenced by

(1) The IES Code
(2) Building techniques
(3) The scarcity and cost of clerical labour

These major factors are interwoven. The high cost of labour, and the importance of recruiting and keeping it, will advance the acceptance of IES lighting standards, whereas modern building techniques with their emphasis on low ceilings will call for better lighting engineering to achieve them. Low ceilings are encouraging the use of recessed diffusing ceiling modules in place of diffusing fittings but such modules present glare problems which are aggravated by the dark ceilings which result from the absence of upward lighting. An obvious improvement which suggests itself is to use louvered rather than diffusing fittings but even this will be ineffective unless the louvers have the effect of substantially reducing the beam spread of the fittings. There is a tendency to equate the angle of light cut-off by louvers or other means with glare reduction but this is misleading because increasing the blade depth of translucent or light coloured louvers tends to leave unaltered, or may actually increase, the ratio of sideways to downward light emission which is a basic factor in causing glare.

Luminous ceilings

Diffusing luminous ceilings have similar limitations which are expressed in lighting engineering terms by saying that the polar distribution cannot be adjusted to suit the shape, size or colouring of the interior. The IES Glare Index data show quite clearly that for compliance with the glare recommendations either the polar distribution of the light source must become narrower as room length increases or, if the polar distribution is unchanged, the brightness of the light source(s) must decrease with increasing room length.

Luminous ceilings meet the latter requirement by extending the light source area to fill the entire ceiling, an expedient which is satisfactory up to medium illumination levels but which fails when used to give high illumination. The best solution is to use equipment with a restricted sideways light emission, such as can be obtained from deep skirted, properly profiled specular reflectors (in the case of tungsten lamps), or reflectors combined with either optically shaped specular louvers or dark coloured louvers, for use with fluorescent lamps, This represents a break from traditional practice and objection may be raised to the reduction in wall brightness that will normally occur. The solution to this problem seems to lie in adapting the perimeter fittings to make a unilateral contribution to the wall lighting and we may

A further example of perimeter lighting, here virtually essential to give relief in a largely windowless interior.

expect to see this form of installation develop, i.e. central fittings providing glare-free down-lighting with surrounds brightened by modified perimeter fittings which can also serve to light wall charts, filing cabinets etc. Certainly this appears to promise relief not only from glare discomfort but also from the dullness which might so easily become an unwelcome adjunct of glare control in large interiors.

Although there is a strong tendency towards large open office spaces there is also a tendency, encouraged by the flexibility of office partitioning systems, to enclose perimeter areas to form small office spaces for executives. These tend to create lighting problems since the lighting layout may not have not been designed with this in mind. A useful addition to an office lighting layout is the provision of lighting fittings immediately over perimeter windows, an arrangement which will normally prevent lighting problems arising from such partitioning. This lighting arrangement is desirable in any event since windows attract desks like magnets and there is much to be said for maintaining, when daylight fails, a similar lighting emphasis.

As a rule there will be no difficulty in meeting the IES glare limit in small offices but may we hope that in meeting the new illumination requirement of 30 lm/ft² some means will be found of avoiding the rather overpowering display of ironmongery (or plasticery?) which can be one of the less lovable characteristics of fluorescent lighting. Over-window lighting would help to ease this problem.

The long neglect of office lighting as a branch of lighting practice has come to an end. From now onwards the impact of the IES Code will be increasingly felt in regard to illumination levels, glare control, and the sensible integration of daylighting and electric lighting. The office lighting campaign of the British Lighting Council comes most opportunely. It is designed to increase lighting business and good luck to it, for improving office lighting is good business all round, for office owners and renters, office workers, the lighting industry and, indeed, the nation. It is to be hoped that the forthcoming legislation on office conditions will be such as to stimulate this forward movement and not, as may so easily happen, freeze it in its tracks by over caution. The 1961 IES Code has set the right standard for voluntary action. May we not expect that nothing inferior to this will be promulgated by regulation?

Supplementing daylight in offices

By R. G. HOPKINSON, PhD, MIEE, FIES, FRPS

CONSIDERABLE THOUGHT WAS given some years ago to lighting of offices, which resulted in the well-known Post-War Building Study No. 30, The Lighting of Offices published by HMSO in 1952. This still remains the most comprehensive statement on office lighting so far produced, but it is interesting to read it now and to note how very much the practice of office lighting, and indeed of office building as well, has changed during the brief intervening period. The standards of office lighting which are now being advocated by leading authorities, such as the Illuminating Engineering Society, are well ahead of those recommended by the Lighting of Buildings Committee in 1952. Nevertheless it would be true to say that the proportion of offices which reach even the standards laid down then is still small. Most pre-war buildings are still lit to pre-war standards, and buildings put up in the immediate post-war period are little, if any, better, especially from the quality of the lighting if not the quantity. It is only in the best modern buildings that any approach is being made to the standards now being laid down by enlightened authority. Even so, too much lighting technology is being copied from mediocre American practice, rather than making full use of the generally acknowledged lead which British lighting research has maintained for many years.

With office lighting, the problem is rapidly becoming one of amenity rather than of visual efficiency. Office workers are now enjoying standards of living at home which are certainly comfortable, if not luxurious, by pre-war standards. They demand these standards in their offices during the day. A bright, colourful, and generally *comfortable* environment is necessary to attract workers who, because of the shortage of labour, may be able to pick and choose their jobs.

For this reason much of the information which was obtained by the Lighting Committee for PWBS No. 30 may well now be out of date, when concerned with standards, but it is not out of date when dealing with basic facts. For example, in the detailed survey which the Central Office of Information made in 1948 at the request of this Lighting Committee, it was found that 7 per cent of office staff worked in a room without any side windows, 16 per cent worked in rooms where the glass area was less than one-tenth of the floor area, which most regulations require, and that 21 per cent received no direct daylight on their work. This information came from interviews with 1,408 office workers in 358 offices throughout the country, and it is unlikely that these percentages have changed very much since then.

It would be valuable, however, if another survey could be mounted to find out if the desires of office workers about their lighting have changed in any way. For example, the way in which the questions were asked in the 1948 survey reflects the pattern of thought at the time. The fact that it was

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thought necessary to record that 21 per cent of office workers received no direct daylight on their work would indicate that the framers of the questions felt that the lack of direct daylight was something noteworthy. However, it may well be that if good supplementary artificial lighting is provided, the lack of direct daylight may go unnoticed and may not be a disadvantage at all. With our present attitudes to lighting, a new survey might frame the questions in a different way.

A short time ago the Building Research Station wanted to get some idea of the degree to which artificial light was being used in new and in old offices during the daytime on bright days as well as dull days. It is difficult to get reliable information of this kind by questioning. Too many people have 'guilt feelings' about using artificial light during the day. Colour photographs were therefore taken from the outside of office buildings during the daytime, which revealed very readily the extent to which the artificial lights were being left on (Fig. 1). It was clear from these photographs that even in the most modern building workers are leaving their artificial lights on. Clearly the idea of mixed artificial and daylighting is not repugnant to office workers, or if it is, it is felt to be less repugnant than inadequate daylight alone.

This gives the pattern of the future of the lighting of offices. It is well known that there is activity in legislative circles to lay down standards of office lighting. It is not known at the time of writing what these standards will be. The IES Code recommends a level of 30 lm/ft² in all offices where normal office work is done (less if the work is visually easy and more when it is visually difficult). This is a level which cannot easily be attained by daylighting except in the position near to the window. Any attempt to achieve levels of this order over the whole of a large office would require such large areas of glass that on almost any day in the year there would be definite discomfort from sky glare, which on bright days would be intolerable. Large windows can only provide quantity of light at the expense of quality.

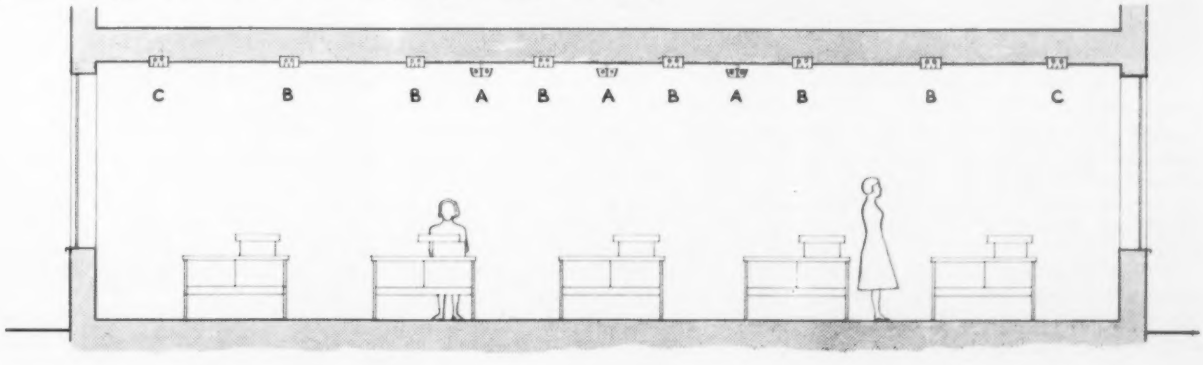
Fig. 1. The artificial lighting is left on, even on a bright day, in this new office building despite the fully glazed walls.

We therefore have to decide whether to follow American practice and light our offices entirely by artificial light, cutting out the daylight by dropping the blinds, or whether to try to blend the available daylight with the supplement of artificial light which is clearly shown to be necessary. The evidence is that people do not prefer to work in inadequate daylight if they can supplement the daylight with good artificial light. On the other hand there is no evidence that people would prefer to work in artificial light the whole time. (American practice cannot be taken to be applicable in this country.)

The technique of permanent supplementary artificial lighting (PSALI) which has been worked out at the Building Research Station[3] enables daylight to be supplemented by artificial light in such a way that the daylight remains dominant, but in correct proportion to the other source. PSALI is not merely a topping up of inadequate daylight; it requires a lighting design employing both sources in which the windows, the reflectances of the interior surfaces, the layout and the light distribution of the artificial sources and the computation of the lighting levels are all worked out in such a way that the whole installation is integrated. Ideally the daylight should be dominant in such a way that the worker may be quite unconcerned that he is working in partial artificial light, even if he is aware of it. The general principles of this technique have been described on a number of occasions. Work still remains to be done, however, in translating these principles into engineering rules. In small offices, Hubble[2] has suggested that the usual two-point grid system should be replaced by a three-point grid system which would lend itself readily to the design of supplementary lighting. For large offices a system has been worked out by Hewitt and his colleagues in collaboration with the Building Research Station which may very well have general application in rooms which are not partitioned (Fig. 2).

Briefly this system consists of arranging the lighting in three sections. One section (section A) is concentrated in those parts of the office which are not adequately lit by daylight. The second section (section B) is disposed uniformly also about those parts of the office which are not lit adequately by daylight, sections A and B together comprising the supplementary lighting. These two sections are computed in conjunction with the known daylighting to give the PSALI system. The third section (section C) is distributed about the rest of the office and on the same plan as section B. This section, together with section B, is

Fig. 2. The Building Research Station ABC system of office lighting; sections A and B together form the permanent supplement whilst sections B and C together form the night-time lighting.



Figs. 3 and 4. Thorn House, London, by day and by night. The daytime view shows the additional fittings used for p.s.a.l.i., which at night are switched off, together with some of the lamps in the units near the centre of the room, whilst others near the window are switched on.

brought into operation at night-time. The night-time lighting therefore consists of a uniform distribution of illumination from sections B and C. An example of this system can be seen in Thorn House in London.

A more simple solution which might be adequate for smaller offices would be a two part system, section A to be designed as the supplementary light, and section B to be added only at night-time. Such a system would have to be a compromise, because the levels required from section A for supplementing full daylight might be much higher than would normally be provided for the night-time lighting.

The problem becomes more complicated if offices are to be partitioned, but the same principles apply. During the day-time people are going to pass from desks lit by full daylight near the window into sections which may be lit only by artificial light except for what daylight can penetrate through a succession of glass partitions. The levels in these interior offices must be of the same order as those in the parts of the building nearer the windows, otherwise those who have to work in the interiors are going to feel an acute sense of deprivation, even if the time interval which occurs when walking from one room to another permits the eyes to adapt. At the moment we do not know precisely what is the cause of this sense of deprivation, and still less do we know how to avoid it short of giving personnel full visual access to the world outside. But it is fairly certain, and this has been confirmed to some extent by research in Russia,[4] that deprivation will be reduced if the quantity and quality of the lighting in the deeper interiors of the building is of a higher order. The Russians recommend that these 'deprived' areas should have from one and a half to two times the normal lighting. This, taken together with the IES normal of 30 lm/ft², would suggest levels of the order of 45 to 60 lm/ft², that is, of the same order as would be provided for PSALI. Although the basis of the Russian approach is different from that of the Building Research Station, the end point seems the same.

The IES Glare Index

Glare discomfort in offices, whether lit by combined daylight and artificial light, by daylight alone, or by artificial light alone, must be kept within the limits laid down in the IES Code. This defines the limiting glare by a maximum Glare Index of 19. Such a Glare Index can be realised in practice with good modern equipment which employs some directional control. Uniformly diffusing lighting units, when employed in large offices to give high levels of illumination, will in general not pass the test. Louvering devices must necessarily be brought into use, and this is equally true over the windows on bright days if any extensive area of sky is visible. The methods for calculating the Glare Index in a combined daylighting and supplementary lighting installation are not simple, but are straightforward and within the professional skill of a qualified lighting engineer. One method for a laylight type of layout is described by Hopkinson and Longmore[3]. The calculation of a symmetrical layout of lighting units can, of course, be handled directly with the aid of the IES Glare Tables.

Illumination levels of the order necessary for blending with daylight are not cheap,

either to install or to run. The cost of this lighting should, however, be included in the overall cost of the building and its maintenance, and if the costing is done on a realistic basis it may be found that the cost of the lighting is more than saved in the better use which can be made of the available site. It would be unfortunate, however, if developers seized hold of this idea of supplementary lighting in order to convert offices into artificially lit caverns on the American pattern. Lighting engineers and architects must collaborate to see that this is not done. More than ever must it be ensured that the use of PSALI will not lead to a wholesale relaxation of daylighting restrictions in city areas. One would hope that the future of city building will be to continue the present tendency to design with large well-spaced blocks which receive, on their exterior surfaces, a full measure of daylight that can be used efficiently in lighting the interiors when supplemented by well designed artificial light. It would be most unwise to set up a conflict between daylight and artificial light when the true use of the sources of light available to us must surely be their proper co-ordination.

Much remains to be done before these new ideas of lighting can be fully applied. One need is for a type of lamp which will be a better match to natural daylight than any fluorescent lamp at present available. Most of the work on fluorescent lamps seems to have been directed either towards getting a 'warm' colour which will not be significantly and noticeably different from filament lighting in its appearance or colour rendering, or to the development of a lamp which will have the properties necessary for good colour matching. None of the lamps which have been developed with these two aims in view are ideally suitable for PSALI. The 'colour matching' lamp is too cold, and the 'deluxe' is unnatural when viewed in proximity to daylight. The so-called 'natural' lamp and the 'daylight' type of lamp are judged best at present for the purpose. (To be precise, however, these conclusions rest only on the Building Research Station experiments. There is insufficient field knowledge at the moment to be dogmatic about what happens in actual offices where subtle problems of colour rendering come to the fore.)

Those who have been concerned with the engineering and subsequent follow-up of PSALI in offices are convinced, however, that the problem of colour rendering in this context has been overstressed. In a supplemented installation, the bulk of the light over the greater part of the room is daylight. The chief colour-requirement of the artificial supplement is that it should not cause distractingly unpleasant colour changes in areas lit partly by daylight and partly by supplementary light. Lamps in the 'cool' range would appear to have the necessary qualities at the high levels of illumination characteristic of PSALI. The development of 'warmer' types of daylight lamp, matched more to sunlight rather than skylight, is being followed up in experiments at the Building Research Station.

The experiments on PSALI have been in the laboratory, apart from one or two pioneer installations. The real experimental stage will be reached when there are enough installations which have been deliberately planned around supplementary lighting, so that we can study them and the reactions of staff to them.

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Installations for office lighting

By E. E. JACOBI, MIEE

THE TERMS LIGHTING ENGINEERING and lighting installation may each be interpreted in two ways, the first covering the design requirements of the lighting itself, and the second the engineering requirements of the installation. This article deals solely with the latter, with the emphasis on the special problems involved in the general run of office and similar buildings where the outline is planned before the actual conditions of use are known.

Generally a wiring installation is not designed for lighting without reference to the other electrical services of a building (socket-outlets, power, and so on), and it is, therefore, necessary to extract those details of installation design which relate directly to the lighting requirements from the general installation design of the building, at the same time remembering that normally the installation must be considered as a complete whole. Although the design of an installation would usually start from the service point onwards, in this case it is the ultimate requirements at the outlet points that should be determined as the initial step.

Design Details

More often than not, at the stage at which the electrical installation is being specified the interior design of the building has not received any consideration; indeed in the usual run of commercial buildings the installation is provided at a time when the building is only a shell and when tenancies, the use of premises, or the interior design and lay-out, are not known at all. There will be thus no advance knowledge of the types of accommodation—whether large open spaces or small individual offices—nor of the system of decoration, nor of the type of lamp—whether fluorescent and tungsten—which may be used; even if this latter item can be settled at an early date it may not be known whether bare lamps, enclosed lamps, pendants, surface or recessed fittings will be used. Moreover, lighting intensities vary to a very wide extent; the lowest figure for some parts of an installation might be as little as 5 lm/ft², and for others the highest intensity might be 100 lm/ft² or more. In these circumstances the ultimate lighting load is difficult to assess but certain principles can be adopted to give a lead.

When the requirements of a normal lighting installation are carefully calculated, it will be found that, by and large, one watt of fluorescent lighting per square foot of floor area will give approximately 15 to 20 lm/ft², subject to a variation, high

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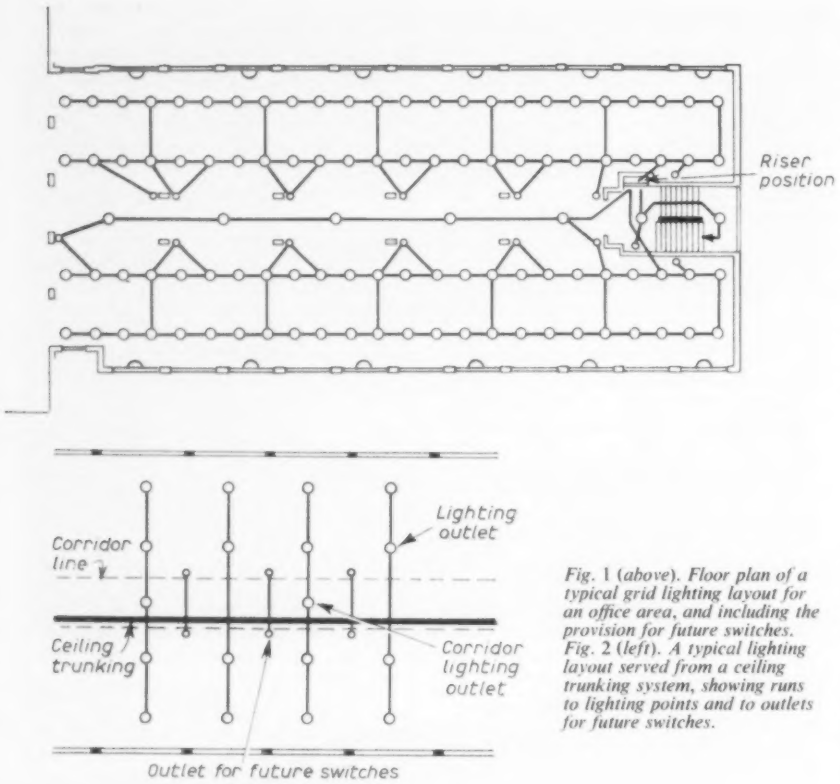


Fig. 1 (above). Floor plan of a typical grid lighting layout for an office area, and including the provision for future switches. Fig. 2 (left). A typical lighting layout served from a ceiling trunking system, showing runs to lighting points and to outlets for future switches.

or low, according to the nature of the installation. With tungsten lamps, the illumination corresponding to one watt per square foot would be 4 to 6 lm/ft².

As some factors have to be taken for granted, it may be assumed that, where lighting intensities are to be no more than 15 lm/ft², either fluorescent or tungsten lamps may be used, and the estimated load should, therefore, correspond to the use of tungsten lamps. Above 15 lm/ft², the use of tungsten lamps would be uneconomic in most cases and fluorescent lighting will almost certainly be chosen. Requirements for the latter may generally be considered as covering two classes of installation; either where special operations have to be undertaken, or where luminous ceilings are used. In these instances a load of 4 to 5w/ft² to give intensities in the range 75 to 100 lm/ft² should be allowed.

In calculating the lighting loads, no diversity can be applied to any particular section of the building; it must be assumed that, in general, all the lighting may be in use at one time. It is possible, however, to apply a factor to allow for the relationship between high intensities of lighting required in some sections of the building, and the comparatively low intensities which will be sufficient in other sections. For example, corridors and service areas require a comparatively low illumination, although sometimes special requirements may have to be met. It will, therefore, be fairly safe, without being wasteful and extravagant on the one hand, or causing insufficiency on the other, if a lighting load of 2 to 3w/ft² is allowed in the design of the general distribution system.

This figure, it will be seen, can cover only the general distribution requirements, and where the distribution is broken down and final lighting circuits are considered, the figure of 4 to 5w/ft² will still hold good for the operational parts of the building. Thus, for building designed for use as an office block with a floor area of, say, 100 ft by 40 ft, i.e. 4,000/ft², a load of 10 to 12kw would be allowed for each floor. These calculations allow details of main switchgear, feeder cables, and local switchgear (all of which, as stated above, must necessarily be considered in conjunction with the other loads of the building and which in some cases will be combined in a single main distribution system) to be formulated.

Distribution

In an article of this nature ranging over general types of buildings, it is not possible to give precise details of the main distribution arrangement; such details follow well defined principles and are such common knowledge among installation engineers that their omission does not affect the aspects of office installation being discussed here. Further consideration, however, must be given to the circuit wiring from the centres of local distribution. Were precise details of the nature of the lighting installation known in advance, outlet points could be plotted without difficulty, but where areas of open building have to be provided for, a decision has to be made on the number of outlet points to be installed and the circuit arrangements required.

Size of building bay

In the large open areas commonly met, the only structural information available is the module or planning grid of the building (generally the window formation in plan) and the number of bays. A bay may be defined as the area bounded on one side by this module, and on the other side by the structural formation of the building with special reference to stanchions and beams. A normal module may vary between 3 ft and 6 ft; the normal depth of a bay from the elevation of the building to the columns will usually be between 20 and 25 ft and a column will only normally occur once every second or third module. Thus a building bay may average 200 ft². It is, therefore, necessary to allow for a possible ultimate loading of up to 1,000w per bay. The precise number of outlets to be left in the ceiling will vary of course, according to the size and shape of each bay but on these figures it will be normal to leave four to six outlets evenly spaced, thus giving one outlet to every 50 ft² or so.

Details of the physical requirements of the wiring needed are referred to in the next paragraphs, but it may be said here that this loading is within the capacity of the sizes of circuit cable normally used. If each bay is ultimately to be controlled by one switch, the total load would be just within the rated capacity of a 5A switch, but in view of the nature of the current used by fluorescent equipment, a standard 15A switch should be used. It is, however, more likely that a smaller number of points would be controlled by each switch, or indeed that each outlet would be controlled by its own switch, and in these cases the standard 5A switch can be used without fear of overloading.

It will be normal to connect the whole of the points in a bay on a separate circuit with its own fuse, especially if the arrangement of tenancies is unknown; individual tenancies may eventually cover a limited number of bays or even one bay only. The fuseboard controlling a number of bays must, therefore, be so designed as to allow for separation of bays for metering and control purposes according to tenancy. For the actual fuse itself, it would be undesirable to use the smallest standard size; the fuse element, therefore, should be rated at not less than 15A if 250v type, or at 10A if 500v type. Alternatively, miniature circuit-breakers may be used.

On the basis of the above calculations, therefore, the size of the fuseboards, the number and size of circuits, and the number and positions of the outlet points, can be

determined. The type and arrangement of wiring now needs to be considered.

Until a few years ago, the ceilings of an ordinary office block simply comprised a layer of plaster on the soffit of the actual load-bearing structure. Such construction might comprise solid concrete, hollow pots, precast beams, or any of the other types or designs available. There is now, however, an increasing tendency to provide false ceilings; these may be needed for housing mechanical services, for their acoustic properties, or for such building design requirements as the provision of a flat ceiling concealing the beams, or to permit the use of recessed lighting fittings. Mechanical services could include the concealing of ventilating and air conditioning trunking and other equipment, or the false ceiling itself might be the heating medium for the building. The acoustic properties might involve the use of sound absorbing tiles which would normally be fixed to the structural soffit by means of battens.

Whatever the reason for the provision of false ceilings, it is evident that their presence will conceal any wiring on the surface of the structural ceiling. Where, however, the provision of a false ceiling has not been decided upon at the time the wiring has to be installed, it will still be necessary to instal outlet points on a module as explained earlier; but given the outlet points on the structural ceiling, a false ceiling will allow modifications and extensions to be made from the outlet points and concealed without difficulty. It also has an important bearing on switch wiring and positioning, as will be shown later.

Local wiring

In broad principle the local wiring installation provided in the structure (or on the soffit of the structure if a false ceiling is to be erected) would comprise either metal or other conduits through which cables can be drawn, or protected wiring, of which mineral-insulated, copper-covered cables or p.v.c. sheathed cables would be usual at the present time, laid direct in the structure without further protection. In certain circumstances it might be considered more convenient to provide holes in the structure during erection through which the wiring can be drawn.

Another method is to provide channels or ducts in the ceiling; this enables wiring to be taken to any number of positions and allows fittings or equipment to be mounted along the runs of the channelling at any spacing required. Such channels would be run on the soffit of the structure or false ceiling according to design, in parallel lines of the order of 7 ft apart. Conduit connections from the fuseboards to the channel and from the channel to the switching positions, are necessary.

In the past, considerable preference was given to conduit, in preference to self-sheathed cable, on the grounds that the wiring could be replaced at a future date. This argument was based on the premise that the insulation of the wiring would deteriorate and finally fail, but where the insulation is non-organic, as in m.i.c.c. cable, or where it is chemically inert, as in p.v.c.i. cables, such considerations do not altogether apply.

A further consideration has been the need to allow for a different use of the outlets during the life of the building. Here again the conduit system cannot be said to be better than the sheathed systems, as any system, including conduit, when once buried in the structure, cannot be altered except by extension from the outlet points. The increasing use of false ceilings does, however, make the alteration of outlets feasible without the necessity of cutting in or running on the surface, and in these circumstances the exact type of wiring material should be judged with reference to the requirements of the building construction rather than future developments.

Switching

Much attention has been given to the problem of switching. As already indicated, provision for switching can be facilitated by the use of false ceilings, but where these are not used, or where provision has to be made in the structure at an early date, a number of alternative methods have been developed.

One early solution was to provide a small number of permanent switching positions at entrance doors to a given wing, and then to use ceiling pull switches associated with each fitting. Where partitions were used to form small offices, extensions would be taken on the surface from the ceiling lighting outlet points to the partitions and thence on the surface of the partitions down to the switches.

Of late, however, a number of alternatives have been used. Where columns exist, it is now usual to provide a number of conduits in the structure of the ceiling from the lighting outlets to positions at the top of each column. On the assumption that partitions would be sited on the modules provided by the columns, it is not difficult to extend from the column into the partition and so to the door. When columns exist only on one side of a corridor line, the switch outlets for the points on the opposite bays have to be left in the ceiling, ready for

Fig. 3. Office area in Manchester illustrating several of the different arrangements referred to in the article: lighting channel and fixing of fittings; acoustic-tile ceiling; switches in partitions and false ceiling corridor lines for mechanical services.

extension when partitions are erected. Another method in common use is to use a duct run at ceiling level along the lines of the columns; the wiring from the fuse-board is taken through the duct and from the duct out to the point positions; switch extensions can then be taken down to partitions from the underside of the duct. Partitions themselves may be made of various materials—bricks, breeze blocks, compressed fibrous material, wood or sheet metals—and most modern designs allow the switch wiring to be concealed within their structure, either by the provision of specially formed grooves, or in the case, say, of a sheet metal partition, by permitting the wiring to be taken through the hollow between the opposite faces. Their design is usually such as to enable flush switches to be fitted.

An alternative method of switching has been developed abroad in which small transformers are used to give a low voltage supply fed into the switching lines. The actual control of the lighting points is carried out by means of relays. With this scheme, runs to switches need only comprise lightly insulated cables (bell wiring) which, being of small diameter, can be run almost anywhere with minimum obtrusion.

There is one other feature of switching design which must be noted; it is the provision which should be made to cater for the creation, at some future date, of a corridor in a space originally planned as a large open office area throughout which the lighting will normally have the same function. When corridors are formed (and in the case of large office areas, where a night watchman may be on patrol), it is important to allow for two-way switching between points of access to the office areas: for example, main staircase and secondary staircase. The doorways opening on to either of these staircases are almost certain to be in permanent walls, and permanent wall switches which can be designed for two-way operation should be installed in the first instance.

Fig. 4. Open office area ready for occupation, indicating the lighting channel used for the mounting of fittings, pull switches and also for the loudspeaker system. Note different spacings of lighting fittings in the rows to cater for individual requirements.

Fixing of fittings

Although a description of the types of lighting fitting which may be used is outside the scope of this article, comment on methods of connecting lighting fittings is, of course, particularly relevant. Obviously ordinary tungsten lamp fittings will be connected through a ceiling plate on to standard fixings on a conduit box. Where pendant fluorescent fittings are used suspended from a solid ceiling, methods must be found for bringing the wiring from the ceiling box outlet to one of the suspensions of the fitting, or, alternatively, a flexible cord may be run from the ceiling outlet straight to the fitting itself. It is desirable in the latter instance to provide plug and socket connection at the ceiling box, permitting easy removal for maintenance or cleaning.

Under conditions of present day practice, particularly in view of generally limited ceiling heights, most fluorescent fittings which are not recessed are fixed directly to the ceiling and questions of special connections do not arise. For recessed fittings in false ceilings supplied from an outlet on the structural ceiling, a plug and socket connection should be used in all cases. Where fluorescent lamps are used remote from their control gear (as might occur with cornice lighting), suitable arrangements must be made for housing the latter and for the wiring from the gear to the lamps.

Heating problems may be encountered, either from the use of a low-temperature heated ceiling system or from the lighting equipment. In the former case, only equipment suitable for use under such conditions may be installed, and if necessary, it must be sited away from the heated areas. In the second case, which is unlikely (as yet) to be encountered with fluorescent lighting, the equipment must, again, be properly designed and any cable or flexible connections insulated with suitable heat resisting material.

Finally, some comments are advisable on fixings. It is now generally realised that a fluorescent fitting with equipment can be heavy. Whereas ordinary fixing methods could be used with tungsten fittings (which in any case would generally be fitted direct on to conduit boxes), special fixings are necessary for fluorescent fittings, especially where suspension points on the conduit system are not available. With the increasing use of recessed fittings, and fittings with remote gear, this problem is not so formidable as it was a few years ago, but it can still arise in many cases. The actual fixing material—plugs, screws or studs—must be decided by the type of structure (solid concrete, hollow pots, precast beams, and so on), and, if necessary, reference made to the manufacturers of special fixings and their advice taken.

OFFICE LIGHTING

Survey of installations

Just how bad, or good, are office lighting installations? The following pages detail 21 office areas whose lighting dates from pre-war to the present day and whose size ranges from those with two or three occupants to those with about thirty. Although the sample is but a minute fraction of the total, it represents the kinds of environment in which most office work is carried out. The information, which was supplied by the Regional Engineers of the British Lighting Council, gives details of the room dimensions, layout and natural and artificial lighting, together with comments on the general impression.

GENERAL OFFICE, BIRMINGHAM; LIGHTED 1946

Room dimensions: 20 ft by 20 ft by 10 ft 6 in.

Occupants: seven.

Work done: book-keeping, invoicing.

Layout: windows 4 ft 6 in. high by 3 ft 6 in. wide, on two adjoining sides of room, venetian blinds fitted; desks in no set pattern, accounts bench along one of window walls; staff face all directions.

Daylighting: intensity good near windows, useful away from windows; average good.

Artificial lighting: tungsten lamps, 150w to 60w, mainly pearl, in white plastics 'Coolicon' shades; no particular orientation. Only those along accounts bench related to working positions; remainder appeared to suit previous desk layout.

Illumination (lm/ft²):	*Day*	*Night*
maximum horizontal	100	20
minimum horizontal	15	3
maximum vertical	60	7
minimum vertical	6	2

Comments: day-time brightness extremely high on desk near windows, falling to very low in far corner; night-time brightness greatest on desks near windows and in far corner, falling off in centre. Fair amount of shadow on work both night and day. Direct glare is considerable from both windows and 150w lamps; fair amount of reflected glare from furniture, which is dark and polished. Lighting obviously bad, but ameliorated to some extent by all-cream décor reducing brightness contrasts.

INSURANCE OFFICE, BRISTOL; LIGHTED 1960

Room dimensions: 60 ft by 32 ft by 13 ft.

Occupants: thirty-four.

Work done: general clerical.

Layout: area is divided into two bays 60 ft by 16 ft by a line of columns 10 ft apart; continuous windows placed in one long side, facing w with unobstructed sky; glare controlled by venetian blinds; staff sit in four rows of desks all facing one way with windows on left hand.

Daylighting: adequate for two rows of desks nearer windows (intensities 150 lm/ft² and 20–25 lm/ft² respectively) but falls off on two rows beyond columns (15 lm/ft² and 5 lm/ft²) and is not normally supplemented during summer months; central row of columns presents 20 per cent obstruction.

Artificial lighting: fluorescent; four rows (8 ft apart) of six twin 5-ft trough fittings suspended 1 ft from ceiling at 10 ft spacing across the line of sight; metal troughs with opaque sides, giving 60 per cent downward light, 30 per cent upward.

Illumination: estimated in daytime at 15 lm/ft² horizontal, with 10 lm/ft² vertical at typewriters; at four-drawer filing cabinets, horizontal illumination varied from approximately 20 lm/ft² at top drawers to about 7 lm/ft² at bottom; vertical illumination probably about half these values.

Comments: brightness pattern (particularly during day) affected by columns; situation aggravated by having senior staff in desks remote from windows to be away from traffic noise; they were unaware of light loss due to columns until informed of it and will now probably use artificial lighting during day; columns also cause shadows across desks; direct glare unlikely to be troublesome but reflected glare likely from dark desk tops and polished dark wood panelling on columns.

PUBLIC BODY, KENT; LIGHTED 1947 AND EARLIER

Room dimensions: 50 ft by 35 ft by 10 ft.

Occupants: twenty-three.

Work done: general clerical and card filing.

Layout: two windows 10 ft by 8 ft in shorter wall facing NE, three smaller windows (total area 95 ft²) in opposite wall; desks arranged at right angles to windows, staff facing one or other of longer walls.

Daylighting: adequate near windows falling considerably towards centre; not normally supplemented by artificial lighting.

Artificial lighting: tungsten, fifteen industrial diffusing reflector fittings using 200w lamps, suspended direct from ceiling.

Illumination (lm/ft²):	*Day*	*Night*
maximum horizontal	300	15
minimum horizontal	12	10
maximum vertical	—	10
minimum vertical	—	5

Comments: ceiling and upper walls necessarily dark as result of fitting distribution characteristics and of surface finishes (ceiling of mustard colour, 60 per cent reflection factor; walls blue, 50 per cent reflection factor); for same reason, fairly hard shadows cast on work; little direct glare but noticeable reflected glare from bright surfaces of equipment; occupants expressed general satisfaction with lighting.

PRODUCE BROKERS, BRISTOL

Room dimensions: 24 ft by 15 ft by 11 ft.
Occupants: six.
Work done: typing and general clerical.
Layout: two windows 7 ft 6 in. high on one long side, facing N with unobstructed view across wide road; desks in two rows of three with staff having left hand to windows; counter at one end; filing cabinets at back, on left when facing windows.
Daylighting: reasonably good; desks nearer windows get about four times as much horizontal illumination as those on far side.
Artificial lighting: tungsten; 100w pearl lamp in conical opal shade over each desk, and two more over counter; mounting height about 7 ft to be within easy reach for switching on and off at lampholder, normal method of control.

Illumination (lm/ft²):	*Night*
maximum horizontal	12
minimum horizontal	4
vertical (typewriters)	2
vertical (filing cabinets)	4–8 top, 2–3 bottom

Comments: dingy decorations with match-boarded walls and ceilings in brown gives hardly any brightness anywhere; individual tungsten lamps give hard shadows and considerable glare but staff (mostly middle-aged) do not seem to mind and like facility of individual switching; in general, an interesting relic of the past which needs modernising throughout.

PUBLIC BODY, SUSSEX; LIGHTED 1958

Room dimensions: 40 ft by 13 ft by 8 ft.
Occupants: five (provision for expansion to ten).
Work done: general clerical.
Layout: eight windows, 4 ft wide by 5 ft high along one wall, facing S; all desks sited next to windows at right angles to them; staff face either way.
Daylighting: good throughout; reflection from light-coloured surfaces make for uniformity; minimum illumination on bright day 50 lm/ft².
Artificial lighting: de luxe warm white fluorescent; nine 5-ft, 80w single lamp batten fittings with diffusers, ceiling mounted in two rows parallel with windows and with line of site, with one across line of sight at one end.

Illumination (lm/ft²):	*Night*
maximum horizontal	35
minimum horizontal	20
vertical	20

Comments: all parts were brightly lit, with a good overall distribution of light, assisted by use of wall and ceiling surfaces with reflection factors of 70 per cent or more, so that any shadows on the work were eliminated; the high brightness of the fittings was not at all noticeable due to low contrast between fitting and ceiling and foreshortened end view of the fittings from working positions.

WIRE MANUFACTURERS' OFFICE, WARRINGTON; LIGHTED 1958

Room dimensions: 30 ft by 30 ft.
Occupants: nine.
Work done: general clerical and typing.
Layout: six windows, 4 ft square, in one wall; desks in no regular arrangement and staff face all directions.
Daylighting: adequate near windows only; very poor against wall but rarely supplemented.
Artificial lighting: mixed; three 150w tungsten lamps in white plastic shades of 'Coolicon' type and six 80w batten fittings suspended on chains.

Illumination (lm/ft²):	*Day*	*Night*
maximum horizontal	80	26
minimum horizontal	2	12
vertical	NA	6·5

Comments: many dark patches created, although decoration in good order; few shadows on work but glare considerable; general impression is that installation is badly planned and wasteful, although staff consider it to be satisfactory; they also tend to work under poor natural light as long as possible.

INSURANCE OFFICE, BIRMINGHAM; LIGHTED 1960

Room dimensions: 45 ft by 45 ft by 9 ft 6 in.
Occupants: fourteen.
Work done: correspondence and accounts.
Layout: windows 5 ft 6 in. high by 45 ft long, on opposing sides of room; desks arranged at right angles to windows; staff face one way with windows at each side.
Daylighting: near windows, a useful supplement to artificial lighting, which is usually left on irrespective of daylight conditions; away from windows, daylighting adds little to general level of illumination.
Artificial lighting: fluorescent, twin, 5 ft, 80w recessed fittings (which are cross-louvered, with serrated louver faces) in five rows of five fittings, parallel with line of sight.

Illumination (lm/ft²):	*Day*	*Night*
maximum horizontal	125	35
maximum horizontal	55	35
maximum vertical	60	30
minimum vertical	40	30

Comments: brightness largely uniform over working areas, with virtually no shadow on work and total absence of glare. General impression is very good, although improved by more colour and interest in décor.

GRAPHITE MANUFACTURERS, NEWCASTLE

Room dimensions: 20 ft by 18 ft.
Occupants: one (chairman's office).
Work done: managerial.
Layout: 6-ft high windows in one side only; desks arranged generally parallel to windows, occupant faces away from them.
Daylighting: good.
Artificial lighting: fluorescent; two continuous wall-to-wall runs of twin 125w natural lamps in recessed troughs, parallel with windows.
Illumination: 50 lm/ft² (horizontal).
Comments: partitioning and polished, dark, desk tops give specular reflection but glare not distracting; no shadows on work; general impression is that lighting is comfortable.

TEXTILES COMPANY, YORKSHIRE; LIGHTED 1959

Room dimensions: 30 ft by 19 ft.
Occupants: four.
Work done: machine accounting.
Layout: all windows on one of shorter sides only; desks arranged in no set pattern; staff face parallel or away from windows.
Daylighting: little use made of natural lighting; glare controlled by venetian blinds.
Artificial lighting: fluorescent; 5-ft, 80w white lamps in twin ceiling mounted fittings with louvers of opal acrylic in two rows with longer axes parallel to windows.

Illumination (lm/ft²):	*Night*
maximum horizontal	50
minimum horizontal	40
maximum vertical	30
minimum vertical	25

Comments: brightness patterns on ceiling are disturbing but acceptable elsewhere; little shadow on work and little glare; general impression good.

PUBLIC BODY, EDINBURGH; LIGHTED 1960

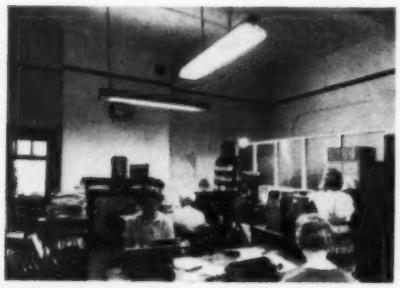
Room dimensions: 40 ft by 30 ft by 13 ft (estimated).
Occupants: twelve.
Work done: typing.
Layout: originally room in private house, with large bay window, and narrower side window, at one end, about 8 ft high; some desks grouped end on to bay, others in no regular arrangement; staff face all directions.
Daylighting: good; trees some distance from window screen sunlight.
Artificial lighting: fluorescent; seven twin 5-ft, 80w trough fittings suspended about 18 in. from ceiling, fittings are cross-louvred, with serrated louver faces.
Illumination: from artificial lighting varies between 35 and 37 lm/ft² on desk tops, with vertical illumination of 24 lm/ft²; daylight illumination 270 lm/ft² adjacent window falling to about 100 lm/ft² in centre of room.
Comments: first-class installation in every way; bright surroundings under both natural and artificial lighting, with complete absence of glare.

POTATO MERCHANT'S OFFICE, GLASGOW

Room dimensions: 40 ft by 35 ft.
Occupants: eight.
Work done: typing and general clerical.
Layout: window about 4 ft high occupying upper half of one of longer walls, with smaller window in one shorter wall; desks in no regular arrangement.
Daylighting: poor; windows of obscured glass and covered by wire mesh screens.
Artificial lighting: tungsten; seven lamps, each 75w, suspended about 4 ft above each desk, four lamps in small bell-shaped glass 'shades', leaving lower half of bulb exposed, other three bare.

Illumination (lm/ft²):	*Day*	*Night*
maximum horizontal	9	8
minimum horizontal	5	1
vertical	19 (sunlight)	3

Comments: extremely poor installation; gloomy interior resulting from lack of light and dingy decorations (walls matchboarded and painted brown and cream); glare excessive, both direct from light sources, and reflected from desk tops and typewriter keys.



PROFESSIONAL ASSOCIATION, NEWCASTLE; LIGHTED 1948

Room dimensions: 25 ft by 20 ft.
Occupants: nine.
Work done: general clerical and secretarial.
Layout: large window occupying whole of one wall; desks arranged round periphery and in centre of area, staff facing in all directions.
Daylighting: poor; large obstruction only short distance outside window.
Artificial lighting: mixed; two single and one twin 5-ft trough fluorescent fittings in 'H' arrangement supplemented by three randomly sited 100w tungsten lamps in small glass shades.

Illumination (lm/ft²):	*Night*
maximum horizontal	18
minimum horizontal	6
vertical	8

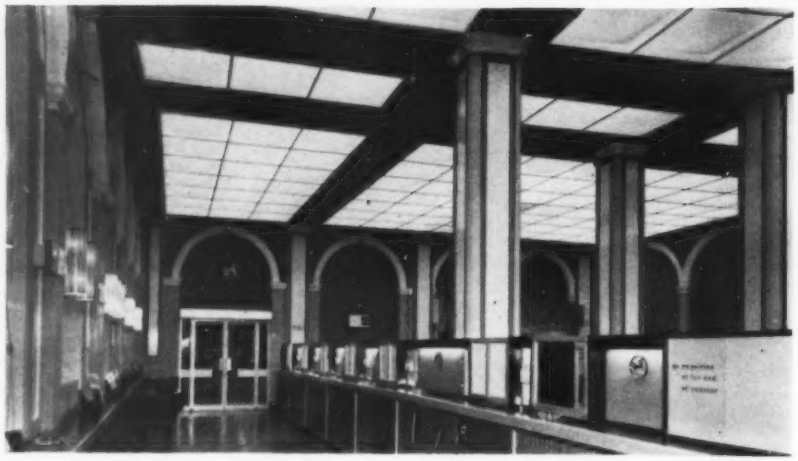
Comments: brightness patterns 'dreadful' with numerous shadows on work; glare irritating, aggravated by reflections in reeded glass of low partition down one side of area. Organization shortly moving to new offices.

BANK, JERSEY; LIGHTED 1960

Room dimensions: 65 ft by 40 ft by 13 ft.
Occupants: twenty-five.
Work done: book-keeping and counter service.
Layout: windows on north side only (public side of counter); desks sited to rear of room remote from windows, towards which staff generally face.
Daylighting: of little value in view of remoteness of desks.
Artificial lighting: fluorescent, with 120, 5-ft de luxe warm white lamps above areas of luminous ceiling of 2-ft square dish-shaped panels.
Illumination (lm/ft²):

maximum horizontal	34
minimum horizontal	15
vertical	28

Comments: good brightness pattern achieved as result of well-chosen decorations and high ceiling; nature of artificial lighting gives few shadows and acceptable glare; overall impression is of 'cool efficiency'.



BANK, GLASGOW; LIGHTED 1946

Room dimensions: 40 ft. by 40 ft.
Occupants: fifteen.
Work done: book-keeping.
Layout: windows in north wall only; desk arranged generally parallel to windows, staff facing away from them.
Daylighting: poor, except near windows.
Artificial lighting: fluorescent; eleven twin 80w ceiling mounted batten fittings sited across line of site, placed in deep, square ceiling bays formed by building structure.
Illumination (lm/ft²):

	Night
maximum horizontal	15
minimum horizontal	3
vertical	5

Comments: exceptionally harsh brightness of fittings combined with reflected light from ceiling bays caused definite discomfort; some reflected glare from desks; shadows on work comparatively little in centre of room, increasing towards walls but not particularly bad; in general, installation reveals error of creating excessive glare in attempting to achieve sufficient illumination on work surfaces.

WIRE MANUFACTURERS' OFFICE, WARRINGTON; LIGHTED 1946

Room dimensions: 21 ft by 21 ft.
Occupants: ten.
Work done: typing.
Layout: 5-ft high window, runs length of one wall; desks parallel to window with staff facing towards it.
Daylighting: good, rarely supplemented.
Artificial lighting: filament; six 150w sited over working areas.
Illumination (lm/ft)²:

	Day	*Night*
maximum horizontal	—	17
minimum horizontal	50	5
maximum vertical	—	5
minimum vertical	—	3

Comments: considerable variation in brightness, in uneven pattern, aggravated by use of dark office furniture and light decorations; lot of shadows on work and some glare although staff have no complaints; it was stated that one employee left because he considered the lighting was adversely affecting his eyes.

TEXTILES COMPANY, YORKSHIRE; LIGHTED 1959

Room dimensions: 54 ft by 30 ft.
Occupants: ten.
Work done: general clerical.
Layout: windows on one of longer sides only; desks arranged in no set pattern, staff face all directions.
Daylighting: acceptable intensity only near windows; usually supplemented by entire artificial lighting.
Artificial lighting: fluorescent; regular arrangement of louvered recessed fittings.
Illumination: 38 lm/ft² (horizontal).
Comments: a comfortable installation, with uniform brightness, negligible shadow on work and absence of glare.

TRAVEL AGENCY OFFICE, GLASGOW; EARLY POST-WAR

Room dimensions: 40 ft by 18 ft by 13 ft (estimated).
Occupants: ten.
Work done: typing and clerical.
Layout: room is divided across by two counters leaving space between for public; window runs along most of one of longer walls, to which desks are placed at right angles and staff face towards either of shorter walls which are hung with posters.
Daylighting: inadequate; normally supplemented.
Artificial lighting: fluorescent; two rows of twin 5-ft, 80w slotted trough reflectors, eight in each row, suspended 11 ft above the floor and arranged across the line of sight.
Illumination: varies between 22 and 24 lm/ft² on desk tops, with vertical illumination of 17 lm/ft²; daylight has negligible effect.
Comments: generally satisfactory; a good example of an early fluorescent installation.

BOOK COMPANY, YORKSHIRE; LIGHTED 1940

Room dimensions: 100 ft by 36 ft.
Occupants: thirty-four.
Work done: general clerical.
Layout: windows 4 ft high along both longer sides; desks face either end walls.
Daylighting: acceptable near windows; but falls off in centre of room, where artificial lighting usually on most of day.
Artificial lighting: fluorescent; single 5-ft, 80w pendant fittings with translucent white plastics troughs, arranged in four rows down room, parallel with line of sight; two central rows separately switched.
Illumination (lm/ft²): horizontal, 12 to 20; vertical 8.
Comments: fluorescent installation from inception; it gives a good brightness pattern despite use of dark furniture, shadow on work is small and glare tolerable, because of light ceiling.

LIBRARY, GLASGOW

Room dimensions: 35 ft by 10 ft.
Occupants: up to eight.
Work done: typing and clerical (librarian's office).
Layout: window in one of shorter walls, with borrowed light entering through glazing in opposite wall; desk and typing table adjacent to latter, and two larger desks (for four people) against side walls with windows at left or right.
Daylighting: adequate only near window.
Artificial lighting: tungsten; three pendant lamps, two fitted with glass spheres, the other with shallow conical glass 'shade'; supplemented by three desk lamps.

Illumination (lm/ft²):	*Day*	*Night*
maximum horizontal	15	8
minimum horizontal	2	—
vertical	—	4·5

Comments: extremely poor installation; excessive glare, particularly from desk lamps and aggravated by dark surroundings.

BANK, BIRKENHEAD; LIGHTED 1955

Room dimensions: 60 ft by 40 ft.
Occupants: twelve.
Work done: clerical and counter service.
Layout: windows sited in wall on public side of counter, supplemented by central circular roof light 15 ft in diameter; desks placed in no regular arrangement; staff face all directions.
Daylighting: adequate.
Artificial lighting: fluorescent; thirteen single lamp commercial fittings, provided with 80w daylight lamps and acrylic diffusers, mounted at 10 ft 6 in. and uniformly spaced over working area.
Illumination: details not available.
Comments: fairly light interior, although much dark wood and brown paint in evidence; staff generally consider lighting conditions to be satisfactory, although comptometer operators complain of glare from fittings.

MERCHANT BANK, LIVERPOOL; LIGHTED 1951

Room dimensions: 26 ft by 10 ft.
Occupants: five.
Work done: general clerical and typing.
Layout: two windows, 4 ft by 3 ft, in one wall; desks in no regular pattern; staff face all directions.
Daylighting: adequate near windows and in centre of room.
Artificial lighting: two 80w fluorescent trough fittings supplemented by one 100w tungsten fitting over teleprinter.
Illumination: Daylight illumination is 80 lm/ft² by windows, 20 lm/ft² in centre; artificial lighting gives fairly uniform 10 lm/ft².
Comments: considerable variations in brightness over room and shadows on work, although glare is stated to be not serious; generally, a poor installation, which is to be modernised in near future.

Two impressions stand out strongly from this survey. The most immediate is that whilst some offices are lighted very badly indeed, their relighting to acceptable present-day standards could be effected with relative ease, based on the use of lighting fittings properly related in design, performance and siting to the nature of the interior. The second impression is that many office workers appear to tolerate atrocious working conditions. This seems to be particularly noticeable in offices where the average age is high and where, presumably, the staff have worked together in that environment over a considerable period; it seems to indicate that the bad conditions are accepted out of habit and from lack of knowing better. As is concluded elsewhere in this issue, the crux of the matter is education. One other impression may be noted; it is that good lighting installations can easily be spoilt by unimaginative décor, in which insufficient attention is paid to variations in brightness and colour.

LIGHTING ABSTRACTS

OPTICS AND PHOTOMETRY

1024. Measurement of visual information cues. 612.843.36

H. L. LOGAN and E. BERGER, *Illum. Engng.*, **56**, 393–399 (*June* 1961).

Lighting techniques, in which severe restrictions are imposed on the available range of luminances, introduce a 'sameness' into lighting environments so treated. Subtle differences in degrees of 'sameness' between different environments can be subjectively identified, but their photometric interpretation is difficult. The authors have adopted for the purpose a measure of 'visual autocorrelation' devised by E. R. Kretzmer. This relates individual contrast values in a scene to the overall contrast value of the scene. The technique is applied to examples drawn from interior and street lighting where the autocorrelation curves demonstrate differences between the actual scenes being compared. A first attempt is made to determine an overall numerical measure of 'sameness', but it is pointed out that a fuller interpretation of the values so determined has yet to be made. P. P.

1025. Electroluminescent lamp brightness measurement 621.327

R. W. WOLLENTIN, S. R. GOLDFARB and D. C. BELL, *Illum. Engng.*, **56**, 405–410 (*June* 1961).

The dependence of the light output of electroluminescent lamps on temperature, operating voltage and frequency means that a close check has to be kept on these parameters when making photometric measurements on these lamps. The Spectra Brightness Spot Meter has been found particularly suitable for measuring the luminances of electroluminescent lamps. One provison is that the colour response of the Meter should be known and any deviations from normal eye sensitivity corrected for. This is important because of the wide range of hues in which these lamps operate. P. P.

612.84

1026. Methods of measuring and calculating equivalent brightness.

Svetotekhnika, **7**, 23–25 (No. 2, 1961). *In Russian.*

A summary of the report of the Russian CIE, E.1.4.1 committee on Photopic and Scotopic Vision. The report does not lend itself to abstracting. Formulae are given for the computation of the visual effect of low brightness in the 'mesopic' range, and it is stated that such 'equivalent brightnesses' can be added within an accuracy sufficient for practical purposes. Measurement is accomplished by *visual* photometry using a standard reference source of 2,042 K. Graduated colour filters to minimise the colour difference in the test and comparison fields are necessary. This method is based on the assumptions of the additivity of equivalent brightnesses. R. G. H.

LAMPS AND FITTINGS

628.971.6

1027. Light transmitting plastic enclosure for outdoor lighting equipment.

D. E. HUSBY and M. R. ANDERSON, *Illum. Engng.*, **56**, 273–277 (*April* 1961).

Tests are described to assess the relative merits of methyl methacrylate and borosilicate glass for the enclosures of street lighting fittings. Impact tests on flat sheets and on moulded refractors, and studies of the effects of surface scratches and temperature on impact strength, showed that acrylic fittings' enclosures or refractors are not truly unbreakable nor appreciably less susceptible to breakage than similar glass components. Their use must therefore be determined by stability to thermal shock and the fact that they do not shatter but usually remain whole and usable. P. P.

628.971.6

1028. The application of sodium lamps to public lighting.

J. B. DE BOER, *Illum. Engng.*, **56**, 293–301 (*April* 1961).

Tests conducted in indoor and open-air laboratories and on normal traffic routes are described which demonstrate the superiority of sodium lighting over high-pressure fluorescent mercury lighting in respect of perception of test objects, appraisals of discomfort glare and comparisons of apparent brightness. The recent introduction of sodium lamps of integral construction, and particularly of increased luminous efficiency, has meant that merely on operating cost alone a 20 per cent saving over fluorescent mercury is obtained. If installations having 'equivalent lighting levels', based on the results of the above tests, rather than the same lighting levels, are compared, a 35 per cent saving is possible. P. P.

1029. Developments in quartz infra-red lamps. 621.326

W. F. HODGE, *Illum. Engng.*, **56**, 333–338 (*May* 1961).

Although quartz infra-red lamps were first introduced as recently as 1954, there are now over forty types meeting different requirements. By supporting the tungsten filament in the quartz tube by means of tantalum discs, it is now possible to operate these lamps vertically. For aircraft, missile and space vehicle testing, lamps of extremely high loading have been developed. Particular attention has been given to the design of the molybdenum foil seals, involving the use of platinum outer leads, and to the protection of the leads by bending the ends of the tube at right-angles to the main body of the lamp. P. P.

1030. Performance of air-handing troffers. 621.329

E. H. WITTE and B. S. BENSON Jr, *Illum. Engng.*, **56**, 347–352 (*May* 1961).

Lighting fittings combined with air-conditioning inlets have been commercially available in the USA for approximately the last three years. This interval was sufficient to enable an appraisal to be made of the performance of these fittings. This was effected by photometric and other tests in a number of widely distributed installations. Depreciation curves are given for fittings having different rates of dirt deposition, while photographs are reproduced which illustrate different degrees of dirtying. The relative magnitudes of the maintenance factors for similar fittings with and without air inlets are dependent on the air supply system and particularly on the cleanliness of the air supply. P. P.

621.329

1031. Efficiency of use of high-frequency florescent lighting.

M. S. RYABOV, *Svetotekhnika*, **7**, 1–9 (No. 2, 1961). *In Russian.*

The many advantages of running fluorescent lamps at high frequencies are offset to some extent by the need to use frequency converters. The weight of ballasts can be greatly reduced, however. Basic data of various forms of ballasts and converters are given in tabular form, and some costing of the system is also tabulated. Systems in the region of 100–200 kw total load, running at frequencies of 2,500–3,000 c/s off rotary converters are to be investigated experimentally. Consideration is also to be given to the development of semi-conductor frequency-converter devices, and to study frequencies in the 10,000 c/s range for practical lighting purposes. R. G. H.

621.329

1032. Progress in static converters for high-frequency florescent lighting.

W. H. JOHNSON, *Illum. Engng.*, **56**, 379–382 (*June* 1961).

A 1·5 kw, 1,500 c/s high-frequency converter for fluorescent lamp operation was first introduced two years ago. Its successful performance was, however, dependent upon the accurate matching of the transistors. This has now been overcome in a 3 kw converter having similar input characteristics to its predecessor. Descriptions are given of two lighting installations using this larger converter and of a further installation presently being completed in the City Hall at Hamilton, Ontario. Switching is performed via 120v control relays and special provision is made for the easy replacement of defective units. P. P.

1033. Quick starting of florescent tubes. 621.327.5

S. WRETEMARK, *Ljuskultur*, **33**, 67–73 (No. 2, 1961). *In Swedish.*

The factors, such as humidity and poor earthing, which inhibit quick starting, and methods, such as electrode heating, which assist it, are discussed. Circuits for single and double tube working are given and their advantages, particularly regarding longer life of lamps, pointed out. R. G. H.

LIGHTING

1034. The lighting of windowless buildings. 628.973

C. I. KROLL, *Svetotekhnika*, **6**, 22–25 (No. 8, 1960). *In Russian.*

An attempt to determine a fundamental approach to the problem of compensating for lack of daylight in an interior. The illumination provided should be such that the 'dose' of *apparent* brightness over the working period should be the same as by daylight over the same period. Data on available daylight gives the necessary standard, which is evaluated by a formula for apparent brightness proposed by Meshkov. This approach leads to recommended levels of illumination which are substantially higher than the Russian 'norms', but it is stated that to compensate fully for lack of daylighting by increasing the illumination level is impossible for single-shift working. R. G. H.

628.973

1035. Lighting of windowless buildings (heavy industry electricity project).

G. M. KNORRING, *Svetotekhnika*, **6**, 26–28 (No. 8, 1960). *In Russian.*

A practical realisation of overhead lighting with fluorescent tubes to high levels of illumination. Runs of glass-enclosed reflector fittings, each containing four lamps, are disposed about the ceiling, with additional lamps at bay ends to provide a more uniform distribution of illumination. R. G. H.

1036. Lighting windowless factory buildings. 628.973

N. M. GUSEV, *Svetotekhnika*, **6**, 22–24 (No. 9, 1960). *In Russian.*

The interiors of windowless buildings must be decorated with care. Light surfaces to walls, ceilings, floor, machinery and furniture are essential. Machine surfaces should not have less than 20 to 30 per cent reflectance, floors not less than 30 to 35 per cent. Ceilings must be lit to appear light. Windowless buildings can be constructed of translucent materials such as glass block, corrugated glass or resin-bonded plastics. R. G. H.

1037. Daylighting of the National Gallery of the USSR. 628.92

N. N. KIREEV, *Svetotekhnika*, **6**, 1–8 (No. 10, 1960). *In Russian.*

For the viewing of pictures, the level of daylight on the walls of the galleries should be related to the average daylight on a horizontal plane in the room. This relation, denoted by a coefficient K = wall d.f. ÷ average d.f., is examined as a function of viewing conditions. R. G. H.

628.973

1038. Remedying lack of light and u.v. in factory buildings without natural lighting.

N. M. DANTSIG, *Svetotetkhnika*, **6**, 19–21 (No. 10, 1960). *In Russian.*

The author advises against windowless buildings. It is not only difficult to simulate daylight conditions, but even if visual simulation is achieved, there remains a lack of natural radiation in the health-giving ultra-violet. Equipment to remedy the lack of such radiation is described. Staff should be subjected to a regular examination. R. G. H.

628.973

1039. The artificial lighting of factory buildings with no natural daylighting.

N. I. ZOZ, *Svetotekhnika*, **6**, 19–21 (No. 11, 1960). *In Russian.*

Windowless factories have been characteristic of industries where close and constant control on the interior climate is necessary, but they are now being considered for other industries also. The foreign literature gave no help, except that a German survey among workers in windowless factories recorded complaints of 'headaches, colic, burning sensations in the eyes, running eyes, neuralgia and vegetative disorders'. (H. J. WEIST, *Deutches Gesundheistwesen*, 1958, No. 22.) Russian physiologists believe that light has a 'toning-up effect on the vital activity of the human organism', and in view of this, recommendations are made that windowless factories should be lit by florescent lamps, to levels 'one degree' (i.e. $\times 1\frac{1}{4}$) higher than those standardised for the fineness of the work, and in every case never less than 15 lm/ft^2. There should be supplementary ultra-violet radiation within the limits of $\frac{1}{4}$ to $\frac{1}{2}$ of the erythemal dose per working day. The rooms and equipment should be coloured in light tones, not less than 40 to 60 per cent reflectance. R. G. H.

1040. The electric lighting of windowless buildings. 628.973

M. S. RYABOV, *Svetotekhnika*, **6**, 17–20 (No. 12, 1960). *In Russian.*

Reports of a conference held by Svetotekhnika attended by medical, architectural and lighting experts. In spite of the grave doubts which have been expressed about the harm which windowless buildings can cause to health, such buildings continue to be erected. It is therefore desirable to establish standards of artificial lighting even if these, in the absence of knowledge, can only be provisional. The subject is then discussed under the headings Light Sources (recommending fluorescent lighting), Standards of Illumination (recommending higher levels than for buildings which receive daylight), Methods of Lighting (light walls, etc., light on ceilings, but luminous ceilings not justified economically), Emergency Lighting (separate circuits), Lighting Control, Compensation for lack of u.v., Maintenance, and Lighting Systems (advocacy of local lighting in addition to general lighting).

R. F. H.

1041. Theory and practice. 628.93

H. D. EINHORN, *Trans. S. African Inst. Elect. Engrs.*, **52**, 80–85 (*March* 1961).

The chairman's address to the Cape Western centre of the Institute. The author deals with the complementary functions of theory and practice in engineering and their respective rôles in the training of an electrical engineer. A number of the examples are drawn from the author's work in lighting; in particular reference is made to the concept of sector flux in the theory of the subject and its application to lighting practice. The aims of academic training are set out and competence is assessed as a 'product' (in the mathematical sense) of theoretical knowledge and practical experience. J. W. T. W.

628.971.6

1042. Factors affecting the efficiency of street lighting systems.

J. C. YAEGER and H. A. VAN DUSEN Jr, *Illum. Engng.*, **56**, 262–268 (*April* 1961).

The relative efficiencies of street lighting installations using filament lamps operated in both series and parallel circuits, mercury vapour lamps operated from reactor and constant wattage ballasts and fluorescent lamps of both standard and 'controlled spot cooling' types are considered in relation to such factors as initial lumens per watt, depreciation throughout rated life, and the effects of wind, ambient temperature, line voltage drop and lamp burning position. Although gas discharge sources are superior in lumen output and luminous efficiency to incandescent lamps, there are still several directions in which greater advantage can be take of this superiority. P. P.

628.971.6

1043. Roadway brightness and illumination as related to luminaire distributions.

A. W. FOWLE and R. L. KAERCHER, *Illum. Engng.*, **56**, 279–286 (*April* 1961).

Satisfactory street lighting depends on a large number of factors of which the roadway illumination is probably the simplest to compute. The Dutch 'Recommendations on Public Lighting' (1959) advocate a single factor whereby average roadway luminance can be roughly determined from average roadway illumination. It is demonstrated that for a number of different street lighting systems this factor is not by any means constant. In any case, brightness contrast, which has been worked out and plotted for fittings with a number of different distributions, gives a better, but not complete, measure of the effectiveness of the lighting. A proposal is made that modern computer techniques be employed to derive the necessary photometric data for a more complete assessment of the effectiveness of individual street lighting systems. P. P.

NEW PRODUCTS

Brighter shop windows

IN REPLY TO SUGGESTIONS that shopkeepers in this country could do much more to brighten their window displays, it has often been complained that the small business man has neither the time nor the money to study the sophisticated display techniques practised by the multiples and large stores. This complaint has now been removed by an enterprising London firm who have introduced into this country a variety of ready-made display components which may be purchased over the counter, so to speak, for window and interior display use. The idea, originated by a Danish business man, Knud Jörgensen, has already proved immensely successful in Scandinavia and Germany. Lighting being an integral part of good display, the same firm are acting as exclusive wholesalers for the entire Atlas range of display lighting fittings, decorative glassware and the A-plan fluorescent fittings.

Irvine, Martin and Co Ltd, 4 Newman Street, London, W1.

Cantilever platform staging

WHILST CONVENTIONAL staging will solve most problems of access to lighting fittings for maintenance or relamping, more often than not there still remain a few fittings so sited in relation to plant or equipment as to be out of reach. To overcome this difficulty, Martin Thomas Ltd have added a 'Hi-Reach' platform to their 'High-Way' range of staging, which comprises a cantilever platform capable of carrying loads of up to 200 lb. Its use enables easy access to be gained to maintenance points situated over such obstructions as shop counters, machine tools and the like. The construction is of heat-treated aluminium alloy tubular frames, which, together with snap-action hooks, can be erected into staging assemblies in a matter of minutes. Braked castors are fitted to the front legs so that the staging may be immobilised when required.

Martin Thomas Ltd, Hayes Road, Southall, Middlesex.

The Martin Thomas 'Hi-Reach' cantilever staging platform enables access to be gained to lighting fittings over obstructions.

Small mushroom

ATLAS ANNOUNCE the addition of a 40w mushroom-shaped lamp to their range. Its list price is the same as their 60w and 100w lamps, at 1*s.* 8½*d.*, to which 4*d.* purchase tax must be added.

Atlas Lighting Ltd, Thorn House, Upper St Martins Lane, London, WC2.

Low-brightness mushroom

THIS LAST MONTH has seen the introduction of a new mushroom-shaped silverlight lamp claimed to have a surface brightness almost half that of the conventional mushroom silverlight. This new lamp, the Osram 'Filta-Lite', is said to be unique in combining a titanium dioxide coating with an acid-etched pearl surface. This combination is said to give the lamp advantages in evenness of diffusion, in light quality and reduction of glare.

The 'Filta-Lite' has been launched in a new package offering attractive possibilities for display presentation and self-selection. The individual lamp sleeves and zipper packages are colour coded for wattage rating.

General Electric Co Ltd, Osram Lamp Division, East Lane, Wembley, Middlesex.

Magnetically held flashlamps

THERE CAN BE FEW EXPERIENCES more unpleasant than having to change a wheel, say, on a dark night, holding a flashlamp in one hand and struggling with the jack in the other, particularly if rain and high wind are thrown in for good measure. Philips, however, have now removed one problem by providing a battery torch fitted with magnetic strips on three of its sides so that it can be held in virtually any position on the car; the light beam can then be directed as required, leaving the motorist with both hands free to deal with the trouble.

Philips Electrical Ltd, Century House, Shaftesbury Avenue, London, WC2.

Area lighting fitting

FOR THOSE SITUATIONS where area floodlighting is to be carried out in an environment requiring the daytime appearance of the equipment to look something more than is customary with standard industrial fittings, Falks have recently produced a lantern which is both smart and durable. Known as the 'Fal-Fina' floodlight, it has the usual optical characteristics of an area floodlighting unit combined with a modern 'streamlined' appearance. Durability results from the use of a resin-impregnated glass fibre hood, with a blue-grey colour as standard, and which is supported on a bracket and spigot of die-cast aluminium alloy, pre-treated by the 'Alocrom' process and finished in two coats of white stoved enamel. The reflector is of electro-brightened and anodised aluminium and skirted porcelain lampholder for a 400w, MBF/U lamp is incorporated. Models are available for pole-top, pole-clamp and wall mounting.

Smart, new, area lighting unit from Falks with glass-fibre hood, die-cast alloy support and anodised aluminium reflector.

Falk, Stadelmann and Co Ltd, 91 Farringdon Road, London, EC1.

Lamps for decoration

IN GOOD TIME for the approaching festive season, two firms have recently announced new decorative lamps. One is Courtney, Pope, who have introduced a 10w, 240v lamp, which is also suitable for display purposes, having a bulb with a coloured glass outer jacket with 'spikes' giving an attractive sparkling effect. The outer jacket is available in seven colours—crystal, red, blue, amber, green, amethyst and pink. The other is AEI, who have extended their range of decoration lamp sets, with a set of twenty 45 mm. diameter lamps. The lamps are supplied in a mixture of six colours and are given a sparkling crystal finish. Perhaps the most striking introduction, however, is the 'Silver Spruce', an illuminated Christmas tree supplied complete with twenty coloured miniature lamps. It may be used separately, or attached to a table lamp. For ease of transport and packing, it is supplied collapsed in a 3 in. deep box, being erected by inserting a metal rod into the trunk; fully assembled, it stands 27 in. high.

Courtney Pope (Electrical) Ltd, Amhurst Park Works, London, N15.

AEI Lamp and Lighting Co Ltd, Melton Road, Leicester.

Light Control in Lamps

By JOHN BOUD, BA

A STUDY OF THE FACTORS INVOLVED IN IMPARTING SPECIFIC DISTRIBUTION CHARACTERISTICS TO INCANDESCENT AND DISCHARGE LAMPS

IN THE CONTROL of light distribution there are two extreme approaches. One of these regards the optical system and the light source as entirely separate, the ideal lamp being seen as the closest possible approach to a point source emitting light uniformly in all directions. The other argues for the simplification and security which come from building the light control function into the source itself.

Which is right? Should the production of the distribution most appropriate for the application in hand be a function of the fitting? Or is it wiser to evolve a lamp which itself has the distribution we seek? Clearly, there is no simple answer. But one notices a marked increase recently in the numbers and varieties of lamps which assume at least part of the light control responsibility, and the question arises as to how far this is justified.

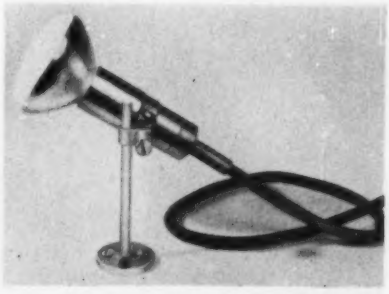
Tungsten lamps

Let us look, then, at some of the tungsten lamps which are designed to have a particular distribution. Pride of place must go to the mains-voltage,* 150w, internal reflector, tungsten spot lamp. In fifteen years this lamp has come almost to symbolise display lighting. A different filament formation, or a frosting of the front of the lamp, produces a wider, 'flood' distribution. A low-voltage* version with its more compact filament has a much more intense beam and, since it runs at a slightly higher temperature, a rather whiter light. A smaller size, for 100 or 75w, is widely used for short-range highlighting, particularly from free-standing fittings set among the items in the display. When the tungsten ballast system of control is used instead of conventional inductive gear for fluorescent lamp operation the ballast lamp may be an internal reflector spot.

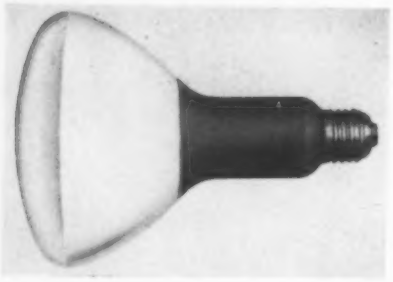
A number of related lamps for larger or smaller wattages are now available. The 500w rating, also spot or flood, is used mainly for exterior floodlighting, though it has a value for intense downlighting from the top of a high shop window. A 375w reflector lamp with a wider distribution was produced a few years back for general lighting in factories. Cleaning has always been a difficulty in high bay installations, and here the internal reflector enables lighting levels to be maintained without frequent servicing. This has proved to be an important principle and one which lies behind the success of a number of later types.

The smaller reflector lamps depend on the concentration which can be achieved with low voltage operation for their effectiveness. The rise in general levels of illumination over the past decade has meant that normal spotlamps have come to seem less effective, and it is significant that while mains-voltage 75w reflector lamps are normally effective only at short range, low-voltage types prove valuable at ratings of 50w and less. Naturally, low-voltage operation entails the use of transformers, so the alternative line of attack was to attempt to make the mains-voltage types more effective by concentrating their beams. With the normal 150w spotlamp there is a limit to this concentration imposed by the bulb being blown in one piece. The reflecting surface has to be deposited and cannot be worked or polished, and the filament assembly has to be completed before it is slid into the bulb.

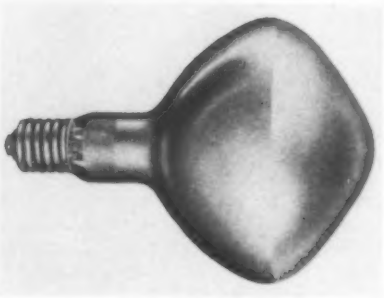
* In this article, mains-voltage is used primarily to denote potentials of 200–250v, but also implies the less common 100–120v, whilst low-voltage refers to potentials of 50v and less.



Top, pressed-glass reflector spotlamp of 150 W in a simple adjustable fitting; it has more than twice the beam intensity of the corresponding blown-bulb reflector spotlamp (Philips). Centre left, 'Cornalux' lamp designed for cornice lighting but also useful for display lighting (Philips). Centre right, reflector lamps of 1½ in. diameter originally produced for use as an aircraft cabin reading light but finding increasing use in display work (Philips). Bottom, 50 W low-voltage reflector lamp used for display lighting (Atlas).



Above, 500W internal reflector photoflood lamp (AEI). Left, high-pressure mercury reflector lamp. Below, a bulb, originally designed for the 'Altrilux' 500W reflector tungsten lamp, used as the outer envelope for 250W and 400W MBFR lamps (Philips).



Right, sealed-beam automobile headlight unit with 60W main and 45 dipped filament and now beginning to be used in this country (GEC).

Below, decorative filament lamps of 60W rating; their large surface area results in a low brightness (Philips).

A new technique of lamp construction was evolved to overcome these difficulties. Heat-resistant glass is pressed into shape rather than blown and the bulb assembled from two parts: the reflector section which attaches directly to the cap and houses the filament, and the front of the lamp which is shaped to be part of the optical system. Work on the inside of the lamp is, therefore, possible; the reflector can be given a high polish and the coiled-coil filament sited very accurately before the 'lens' is fused on. The result is a very robust lamp with more than twice the intensity of the conventional blown-bulb type. It is an incidental advantage that it can be used out of doors in simple fittings which are essentially no more than watertight lamp holders. The performance of these display lamps is shown in the table.

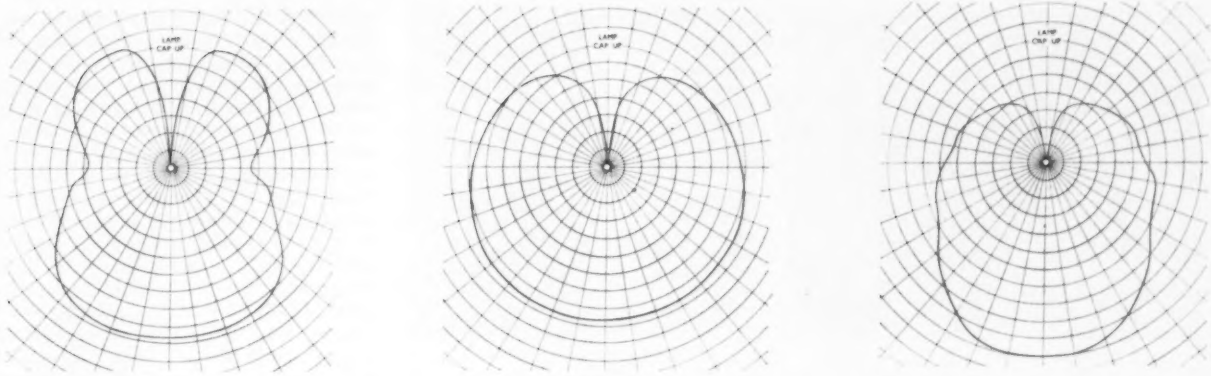
Another type of tungsten lamp with an internal reflecting surface is that with bowl silvering. These have found general use more widely on the Continent than in this country, though fittings for the 200w and 300w ratings have been used frequently where a high level of general illumination from tungsten has been desired (only recently a drawing office in an organisation where the anti-fluorescent prejudice still exists has been effectively lighted to 40 lm/ft² in this way). We have, however, seen bowl-silvered lamps being extensively used as the source in high-intensity spotlights which depend on shallow external reflectors. Here the silvering collects the light output on the reflector, and at the same time eliminates stray direct light from the lamp outside the beam. The types in wide use include a 100w rating at both mains and low voltages and a smaller 50w, 12v lamp. There is also a 150w lamp of this kind which operates at 24v in a special fitting designed for long range flood lighting which has been used in a number of 'Son et Lumière' spectacles. For completeness any account of tungsten reflector lamps should mention the photographic lamps of the 'photoflood' type which appear in reflectorised form at 275 and 500w, and of course, the infra-red types.

There is no doubt that these varieties of lamp have, in practice, more than justified their existence. The fact that an internal reflector is protected from dust, scratches and corrosion, cannot get out-of-true, and makes for a compact source, seems more than to compensate for its having to be replaced with the lamp. Confirmation comes from the ever increasing application these types are finding. In one sense it could be said that in an affluent society all lighting tends to display lighting. It is certainly true that once we pass beyond the minimum functional requirement, decorative lighting today is, at last, being thought of in terms of where the light goes rather than of the appearance design of fittings. It follows that this preoccupation with distribution should throw an emphasis on lamps which themselves provide the kind of spread which is appropriate. This tendency is beginning to be noticeable even in domestic lighting, and this may lead to the appearance of lower-wattage mains-voltage types. One company produces a 60w lamp in the now familiar mushroom-shape bulb which has a diffuse reflector material deposited in its neck, but this is intended solely for a particular range of decorative fittings. There is in France a range of small blown-bulb reflector lamps (overall length 109 mm, diameter 80 mm) which come in ratings of 100, 75, 60 and 40w. Another Continental development, recently introduced here, is a 150w mushroom-shaped lamp with a dense silica-type coating over most of its surface but an area of normal pearl finish opposite the cap. This is designed for use in diffusing domestic fittings when a downward emphasis is appropriate.

Discharge lamps

Tubular fluorescent lamps with internal reflecting surfaces have been in use for some years now. Obviously there is no question here of the production of a concentrated beam, and the reflector takes the form of a powder instead of a metallic coating. This construction has been applied only in the case of the 'high efficiency' colours, but there are four ratings available, from 20w to 125w. When this type first appeared it was felt that its main application would be in places where an external reflector was not possible, and it has certainly been used for show-cases and in high illumination schemes (such as in horticultural lighting) where the tubes have needed to be close together. But, paradoxically, the most widespread use of reflector fluorescent lamps has been industrially in conventional troughs, which act as screening and provide the necessary cut-off (the 'window' area is twice as bright as the surface of the conventional type). The light output from the fitting is very largely independent of the depreciation of the external reflector, and is very little affected by the inevitable dust layer on the top of the tube. Slotted reflectors still have their point, for enough light escapes through the reflector coating to avoid 'tunnel effect'. For a slight extra initial cost, but no extra running cost, reflector fluorescent tubes make possible higher maintained illumination levels in industrial conditions. This is particularly important in installations where the fittings are hard of access or where regular cleaning is not carried out.

The same point arises when we come to a discharge source finding increasing use in industry today, the reflector version of the fluorescent bulb (or 'colour-corrected') mercury lamp. At present this type is manufactured in two ratings of 250 and 400w. The inner quartz discharge tube is sited in the glass envelope used for the 500w tungsten reflector lamp, and the fluorescent powder responsible for the improved colour performance is applied to the diffuse reflector surface but not to the



Polar diagrams of, left, coiled-coil, centre, single-coil and, right, 'mushroom' lamps, showing the extent to which conventional light sources exhibit directional characteristics.

front of the lamp. Further ratings and developments can be expected.

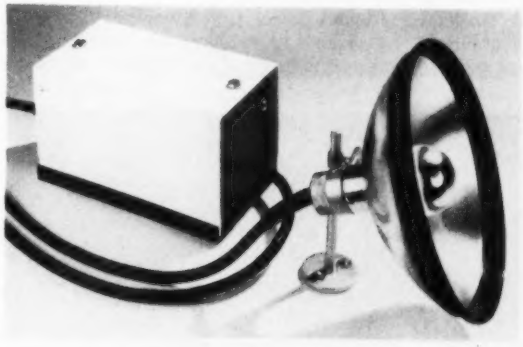
Surprising results have been obtained with these lamps in high-bay industrial schemes particularly as replacements for high wattage g.l.s. lamps. At the de Havilland Aircraft Company's Hatfield Works 400W, MBFR/U lamps have replaced 1,000W tungsten lamps, the dispersive reflectors being retained simply as housings, with the result that the illumination has been more than doubled while the loading is reduced to less than half. Another important point about this installation is that the spacing in the existing scheme approached a maximum, the mounting height being 24 ft and the separation of the fittings 30 ft in one direction and 34 ft in the other. Yet the uniformity of the illumination from the MBFR/U lamps proved completely satisfactory; this is because their distribution is much wider than that of most reflector types—the intensity is almost unchanging over an angle of 40° each side of the axis of the lamp. If one suspects that conventional mercury lamps will be replaced as time goes on by the colour-corrected mercury types, it seems likely that these reflector versions will enjoy a large share of industry's discharge lighting.

Other reflector discharge types have at the moment only specialised uses. There is, for instance, a 125W, MBR/U lamp used in printing and a blended reflector lamp with horticultural and photo-chemical applications.

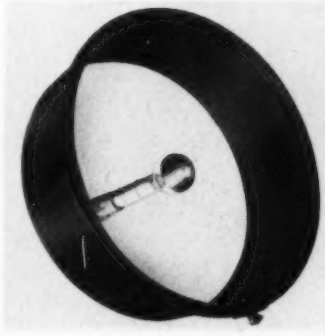
Conventional lamps

It is as well to remember here that many of the lamps which we do not think of as being designed to make a contribution to the way their light is distributed are a long way from emitting light uniformly in all directions. The differences from this theoretical spherical output have an important effect on any consideration about the right lamp to use and emphasise how often a fitting has to be designed for one lamp and one lamp only. When we replace a single-coil g.l.s. by a coiled-coil lamp of the same rating, or even by a mushroom-shaped type, or when we are considering whether a clear, pearl or silica-coated bulb is more appropriate, we must remember that these categories differ not only in light output, size and diffusion but also in their distribution. The result naturally depends on the type of fitting, but to take a possibly naïve example, replacing a clear lamp in a deep drum opaque shade by a silica-coated equivalent, could well mean more light coming from the fitting in spite of the absorption in the diffusing material.

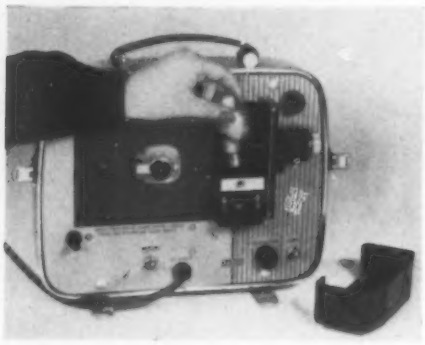
In using all tubular types of lamp we must of course bear in mind that distribution from a line source is very different from that from a point. However, in many cases this difference can prove to be an advantage, and it can often be used positively to go some way towards giving us the spread we want. In conventional streetlighting, for example, the light from a tubular source at right angles to the traffic flow needs refining, but it is already, in a broad sense, moving in the right direction. This is even more the case with conventional sodium lamps, provided, of course, one limb of the U is vertically above the other. In a different sphere, that of lighting a general office or a class room, aligning fluorescent fittings so that the tubes are seen end-on is another example of making positive use of the distribution characteristics of such an extended source.



Left, low-voltage bowl-silvered lamp of 50W used in a shallow reflector to produce a very concentrated beam of high intensity (Atlas).



Left, a weatherproof projector fitting using a bowl-silvered low-voltage lamp of 150W and which may be used for long-throw exterior floodlighting as well as for interior display purposes (Atlas). Right, another type of shallow reflector fitting using a 100W bowl-silvered lamp which may be either of mains or low-voltage operation (Philips).



Left, this picture of a 'Brownie Eight-58' cinematograph projector shows the lamp on which its simplicity depends; it is an 8 V, 50W lamp having a bulb which is almost entirely silvered (Kodak). Right, a 'Tru-Flector' lamp used for cinematograph projection (Atlas)

Reasons for refinement

What emerges from all this is that there seem to be two separate reasons for using light-control lamps: firstly, because the degree of optical control desired is most conveniently achieved in this way and, secondly, because of the alleviation of maintenance problems. It does seem that most of the important new lamps with built-in control which we have seen in the last few years have the second of these two reasons behind them. This is obviously the case with reflectorised fluorescent lamps and almost as self-evident with the reflector forms of colour-corrected mercury. In industry today there is a great preoccupation with the economics of maintenance, and managements are coming more and more to the conclusion that although no maintenance lighting may be just a dream, some approach to this ideal can prove extremely valuable.

One question which is sometimes asked can be dismissed at this stage: 'Do light-control lamps make fittings superfluous?' If we think, say, of a fluorescent mercury reflector lamp it clearly needs a holder, and that holder needs to be supported. It will normally be advisable to provide some protection, and so at least part of the lamp is surrounded by a metal housing. Thus we have at once a combination of support, lampholder and housing, which is very close to being a fitting. True, it makes no contribution to light control, but this is, after all, only one of the functions of a normal fitting. The same situation exists in the cones, torpedoes and other shapes which have for years housed reflector spot-lamps in thousands of shop windows. They, of course, have a screening function, and this is something which is likely to remain with the housing as lamps with built-in light control can often prove a more dangerous source of glare than their more orthodox equivalents.

This brings us back to the use of conventional troughs with reflector fluorescent tubes, and to an interesting development, related to the minimum desirable spacing for fluorescent lamps within a fitting. To take advantage of the fact that lamps of the reflector type can usefully be closer together than those with a general distribution, at least one new range of fluorescent fittings now offers the basic mounting channel with two types of twin lamp holder. One is for two lamps at $2\frac{3}{8}$-in. centres intended for use with orthodox lamps, while the other is for two lamps at $1\frac{7}{8}$-in. centres for reflector tubes. Among the attachments, the $6\frac{1}{2}$-in. wide trough, for example, acts as a reflector for one orthodox lamp, or as a cut-off screen for two of the reflector type; similarly, the 9-in. wide trough takes two orthodox lamps or three more closely spaced of the reflectorised version. This whole development is important because the close spacing of fluorescent lamps naturally results in economy, and with reflector types the question of obstruction and absorption need concern us far less.

There is a fairly firm distinction between lamps with inherent light control mainly for maintenance reasons, and those where the building in of reflectors is a matter mainly of convenience. One should, of course, beware of too sweeping a generalisation about this as the development of almost any type of lamp is often followed by its use in applications the designers could not have foreseen. To take a specific example, the 'Cornalux' lamp, evolved specifically for cornice lighting, has a fan-shaped spread of light which has found application frequently in display lighting, and there have already been examples in London's West End of the use of fluorescent mercury reflector lamps in shop windows, while in South Africa this type has been used to light displays of diamonds.

For what is perhaps the ultimate in built-in light control we must turn to projector lamps, and as an example of what is now being achieved we may take the 8v, 50w lamp which has been developed for 8 mm cine projection. A concentrated filament is situated at the primary focus of the ellipsoid which constitutes the rear half of the bulb and which is externally silvered. The front portion is spherical in shape with its centre at the filament and is also silvered with the exception of a window of about 2 cm diameter. A very high optical efficiency thus attends the formation of an image of the filament at the secondary focus and the gate of the projector is placed here, the system being adjusted so that the size of the image coincides with that of the gate. An objective lens is the only other necessary optical component and a very simple projector results. The screen illumination with this system is greater than that achieved in comparable projectors using 500w lamps of a more orthodox type. Is it fanciful to anticipate the development of lamps for display lighting along these lines? If such

A production area at the Battersea works of S. N. Bridges & Co, where reflector fluorescent lamps are used in orthodox slotted trough fittings; the picture shows that enough light escapes upwards to give an adequate ceiling brightness (Philips).

a unit were recessed, a tiny hole in the soffit of a shop window could coincide with the secondary focus through which all the light passes; brightness would, indeed, seem to fall from the air.

Future possibilities

We began by asking how far the recent increase in the number of types of lamp with built-in lighting control was justified. Any lamp can of course be misapplied, but experience with these types has shown that their development has met a real need. They do not, however, make fittings superfluous, although they may mean that we shall be talking of 'housings' rather more in the future. If one risks a forecast it must be one in terms of the two distinct reasons for the existence of these lamps. The types with mainly a maintenance justification, and which find that their major application in industry, are likely to show marked increases in the numbers used and to be produced in greater variety. We can expect to see more reflector type fluorescent lamps, including those with high loading, and further ratings of MBFR/U lamps. As time goes on the distribution of this last type is likely to become more concentrated, which will mean, of course, closer spacing but will permit better screening from the housings employed even at mounting heights where at present we pretend this aspect can be ignored.

Reflector Lamps and High Intensity Spotlight Fittings: Performance at 10 ft.

	Illumination in beam centre, lm/sq ft	Beam width (between points at which illumination is half that at beam centre), in.
Lamps		
20w 24v reflector	3	60
50w 12v reflector	34	40
100w 240v flood	7	120
150w 240v flood	10	120
150w 240v blown-bulb spot	40	42
150w 24v blown-bulb spot	200	18
150w 240v pressed-glass flood	35	80
150w 240v pressed-glass spot	85	36
External reflector fittings		
50w 12v high intensity spot	280	16
100w 240v high intensity spot	180	21
100w 24v high intensity spot	800	12

In turning to lamps whose design is justified by the elegance of the light control itself, the stumbling-block in exploiting the possibilities here more extensively seems to be the economic doubts aroused by an expendable optical system, particularly as these types are usually tungsten, and in many cases over-run. It might be that the development of the iodine technique will resolve this difficulty, and that for display lighting in particular a new chapter in the story of lighting for selling may follow the evolution of small inconspicuous sources with inherently concentrated beams. Light control within the lamp is certainly here to stay.

Mr Boud is with Philips Electrical Ltd.

I E S TECHNICAL REPORT NO. 2

The calculation of coefficients of utilization

This document introduces an important new method of calculating coefficients of utilization. Known as the British Zonal Method, it is simple to use and gives the lighting engineer a degree of accuracy and flexibility not previously possible. It also offers a new method of classifying lighting fittings which makes possible further simplifications in calculation and forms the basis of the IES Glare Index System.

Price 10*s.* 6*d.*

THE I E S CODE 1961

Recommendations for good interior lighting

This publication marks a significant step forward in the design of lighting installations in that, for the first time, it introduces quantitative methods of assessing glare in projected lighting schemes. The Code also recommends a new approach to daylight design which recognises that in some buildings the permanent supplementary use of artificial light may be required. The schedule of recommended values of illumination has been extended and all values have been revised.

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IES President and Vice-Presidents, 1961-62

W. T. F. Souter

H. H. Ballin

N. Boydell

P. Hartill

W. Robinson

A. H. Young

W. T. F. Souter
The Illuminating Engineering Society's President for 1961-1962, Mr W. T. F. Souter, FIES, joint managing director of Holophane Ltd, began his professional career in the railway industry, joining the London, Brighton and South Coast Railway at the completion of his education at Battersea Polytechnic. He joined Holophane in 1923, and has held progressive positions in that firm's technical and sales departments since then, becoming general sales manager in 1945 (which position he still retains) and being elected to the board of directors in 1949. He has been joint managing director since 1955. His membership of the IES, which commenced in 1924, has been marked by many services to the Society; he has served on the Council on several occasions, and is currently chairman of the Technical Committee. He is also chairman of the BLC and the representative for the electrical industry on the Council of the APLE.

H. H. Ballin
Dr H. H. Ballin, PH.D, B.SC(ECON), ASSOC IEE, FIES, studied at London University and received his early training at the Research Laboratories of the GEC, serving in the street lighting department of that company from 1934 until 1944. He joined Thorn Electrical Industries as manager of their lighting department in 1945. On the formation of Atlas Lighting Ltd in 1957 he was appointed a director and technical sales manager. He is currently chairman of the IES Papers Committee.

N. Boydell
Mr N. Boydell, MIEE, AMI.MECH.E, is manager of the East Sussex and South-West Kent Sub-Area of the South-Eastern Electricity Board. After training at the Leigh and Liverpool Colleges and at the Leigh Electricity Department, he had a number of appointments in municipal electricity departments at Southport, Bedford and Blackburn before becoming distribution engineer with the Eastbourne undertaking in 1933, subsequently becoming that borough's electrical engineer and manager in 1936, which position he held until nationalisation of the supply industry in 1948. He was president of the APLE in 1948-1949. He has served on the IES Summer Meeting Committee for a number of years.

P. Hartill
Mr P. Hartill, AMIEE, FIES, received his technical training at the Wolverhampton and Staffordshire Technical Colleges and joined the Revo Electric Co Ltd in 1931. After serving in their London office from 1934 to 1937, he returned to the head office as assistant manager of the Lighting Department, becoming manager ten years later and lighting equipment sales manager in 1951. He has served and continues to serve on many ELFA and BSI committees, and was chairman of the IES Birmingham Centre in 1949.

W. Robinson
Mr W. Robinson, B.SC.TECH, AMIEE, FIES, who is a technical officer of the British Electrical Development Association, was educated at Manchester University from where he went to Metropolitan-Vickers and, in 1936, was appointed electrical contracts manager at R. C. Cutting and Co. A year later he joined the ELMA Lighting Service Bureau as senior lighting engineer, which position he held (apart from war service in the Royal Engineers) until 1950. He has been noted for considerable work on various committees of the IES (largely connected with technical matters); he has been a member of Council and served as honorary treasurer for three years. Recently he was chairman of the luminance study group set up as part of the preparation of the new IES Code and as such co-ordinated the work on glare incorporated therein. He is also chairman of the lighting design data panel of the IES Technical Committee, in which capacity he was responsible for the preparation of IES Technical Report No. 2.

A. H. Young
Mr A. H. Young, AMIEE, FIES, is deputy chairman and joint managing director of Troughton and Young Ltd, which firm he joined in 1939, having been educated at Faraday House. After war service, he restarted their lighting fittings department and became executive director of Troughton and Young (Lighting) Ltd on its formation. He is a member of the Council and management committee of the BLC and is chairman of the LEDC.

Regional Chairmen, 1961-62

Bath and Bristol
Mr T. O. Pettit has served on the Centre committee on a number of occasions and was for one time honorary secretary.

Birmingham
Mr S. C. Dinenage, AMIEE, educated at Aston and Birmingham Technical Colleges. started his career at Verity's Ltd before joining the electricity supply industry in the Birmingham Electricity Supply Department, where he gained experience in a number of fields and, during the war was involved in the lighting of Hams Hall 'B' power station. In 1947 he was appointed consumers' engineer to the Walsall municipal undertaking, transferring to a similar position with the MEB at Wolverhampton in 1949. At present he is senior assistant commercial engineer for the Wolverhampton and District Sub-Area of the Board.

Cardiff
Mr G. J. Everett commenced work, following education at Hackney Technical College, as a test room assistant at Faraday House Laboratories, leaving to join the Benjamin Electric Ltd as lighting engineer in 1937. In 1949 he changed to Thorn Electrical Industries Ltd, being transferred to their Cardiff office as senior lighting engineer one year later.

Edinburgh
Mr T. L. B. Mackay served an apprenticeship in electrical contracting in Edinburgh. After war service with the REME, he rejoined his father's electrical contracting business as a partner of the firm.

Glasgow
Mr Baker came into the lighting industry from architecture, having studied at the Boltcourt School of Design and Wimbledon School of Art. He served his apprenticeship in the GEC head office and was then transferred to that company's Glasgow office in 1928 to open the new drawing office established there.

Hull
Mr M. C. Zaph has been in the electrical industry for 32 years. From an apprenticeship in electrical contracting, he moved to an electrical wholesaling firm gaining experience in commercial distribution and purchasing. He is now with T. Beadle and Co Ltd, electrical wholesalers, of Hull.

Leeds
Mr K. J. Goddard has been a public lighting engineer since 1932, following training at Nottingham Technical College and Nottingham City Lighting Department. He was a founder member of the IES Nottingham Centre in 1939 and, on his return from war service in 1945, served on that Centre's committee until 1954, when he was appointed deputy city lighting engineer at Leeds. He has served on the Leeds Centre Committee and has been secretary of both Centres.

Leicester
A well-known member of the Society, Mr H. R. Ruff, B.SC, MIEE, FIES, joined the BTH Research Laboratory following a graduate apprenticeship at Rugby. He became head of the Lamp and Lighting Division and, with the formation of the AEI Lamp and Lighting Co, joined them to organise and manage an Application Development Department. He is a member of the Society's Council and Technical Committee, and he represents the IEE on the NIC, being chairman of the Light Source Sub-Committee and a member of the ultra-violet and infra-red experts group of the CIE.

T. O. Pettit

S. C. Dinenage

G. T. Everett

T. L. B. Mackay

H. Baker

M. C. Zaph

K. J. Goddard

H. R. Ruff

Liverpool
Mr N. Blackman, DIP.MIES, entered the lighting industry in 1939, and left it in the same year for war service. On his return in 1945, he took a full-time refresher course in illuminating engineering and joined Verity's Manchester office, transferring in 1947 to the BTH Liverpool office and becoming senior lighting engineer there in 1950. He continued to act as lighting sales engineer for the area after the AEI company was formed. He has served on the Centre committee for many years and has been its secretary since 1957.

Manchester
Mr J. E. Tonge has been closely associated with the artistic side of lighting, having served an apprenticeship with the Morecambe Palladium Co and worked for Odeon Theatres both before and after the war. He joined Courtney, Pope in 1951, becoming Manchester branch manager in 1955, and a technical director of the company last year.

From l. to r.
N. Blackman
J. E. Tonge
R. A. Hall

H. J. Slater

B. Ruston

E. H. Cutler

H. Sutcliffe

M. Johnson

N. B. Ricketts

Newcastle upon Tyne
Mr R. A. Hall, DIP.MIES, entered the lighting industry in 1948, after an engineering career which started with a naval apprenticeship in Chatham Dockyard. He spent ten years with the GEC Newcastle office, leaving in 1959 to become north-east regional engineer for the BLC, which position he still holds.

Nottingham
Mr H. J. Slater, AMIEE, DIP.MIES, educated at University College, Nottingham, joined the Nottingham City Lighting Department as junior assistant in 1937, and has held successive positions in that department becoming city lighting engineer in 1959. He is a founder member of the Centre and has served as its joint secretary.

Sheffield
Mr B. Ruston, DIP.MIES, a silver medallist of the City and Guilds, has been senior technical assistant at the Sheffield Corporation Lighting Department since 1957. He was previously with the Revo Electric Co and with the illuminating engineering department of Rowlands Electrical Accessories. He is also an associate member of the APLE.

South Africa
Mr E. H. Cutler was educated at the Witwatersrand Technical College, started his professional career with the Union Steel Corporation and was awarded the SEIFSA Bursary for 1950, following which he attended the Universities of Natal and Witwatersrand. Since then he became a consulting engineer, forming his own practice in 1957, which last year he amalgamated with another practice to form Mamroth, Roston and Cutler.

North Lancashire
Mr H. Sutcliffe, previously secretary of the Group for the last five years, began his career in the Lytham St Annes Corporation electricity undertaking, remaining with them until nationalisation. He then joined the Commercial Department of the No. 4 Sub-Area of the NWEB, which position he still holds.

Stoke-on-Trent
Mr M. Johnson, a native of Sheffield, trained there and joined the lamp and lighting section of the local office of Metropolitan-Vickers. Since the war he has been resident in Stoke as the local representative of Metropolitan-Vickers and their AEI successors.

Swansea
Mr N. B. Ricketts is also from Yorkshire, being educated at Rotherham and Sheffield Technical Colleges and training with a Sheffield engineering firm. He joined the supply industry in 1950 and since 1957 has been senior assistant in the South Wales Electricity Board's commercial department.

MISCELLANY

Book Review

Radiometric standards and measurements. Notes on Applied Sciences No. 23, published for the National Physical Laboratory by HMSO, pp. iv, 24; 6 in. by 9½ in.; price 1s. 9d.

This latest document in the NPL's series 'Notes on applied science' is devoted to a description of the methods used at the Laboratory for measuring ultra-violet, visible and infra-red radiation. Intended (as others in the series) for industrialists and technicians, its descriptions are essentially practical and give no more than a brief account of the theory underlying the use of the instruments described. There are three main sections, dealing, respectively, with the measurement of total radiation, of monochromatic radiation and with the absolute measurement of radiation. The first section describes the Moll thermopile and then deals with intercomparison of thermopiles, radiation exchange and the measurement of radiant power. In the second section, attention is turned to relative spectral measurements, the absolute measurement of monochromatic radiation and the measurement of the spectral selectivity of thermopiles. The final section is given over entirely to a description of the Guild drift radiometer, which is the equipment used at the laboratory for the absolute measurements. L. L.

Educational

THE NORTHERN POLYTECHNIC has arranged a course of ten lectures, 'Lighting in Building', to be held on successive Thursdays commencing October 5, from 6.30 p.m. to 8.30 p.m. The course has been specially designed for final and post-graduate architectural students, interior decorators and lighting engineers; its content will deal with natural and artificial lighting, the work of the lighting engineer and measurement and design for lighting. Enrolment will take place on the opening night at 6.30 p.m.; registration fee one guinea. Further details may be obtained from the head of the Department of Architecture, Surveying and Building, The Northern Polytechnic, Holloway, London, N7.

FOR STUDENTS planning to enter this field, or newcomers to it, in the Newcastle area, the Newcastle-upon-Tyne Education Committee, in conjunction with the BLC, have arranged a course of six lectures at Rutherford College of Technology on successive Tuesdays (with one exception) beginning October 17. The programme is: Oct 17, Fundamentals of illuminating engineering, by R. J. Fothergill; Oct 24, Interior lighting design, by R. A. Hall; Nov 1 (Wednesday), Office lighting; Nov 7, Present-day light sources, by R. J. Fothergill; Nov. 14, Industrial and other special fields of lighting, by R. J. Fothergill; Nov 21, Exterior lighting, by R. A. Hall. The fee for the course is £2 5*s* and registration is to be made on application forms obtained from the College's Department of Electrical Engineering at Northumberland Road, Newcastle-upon-Tyne, 1, and returned by October 10. The session on office lighting on Wednesday, November 1 is something of an innovation in that the class is for that evening to be incorporated with the meeting of the IES Newcastle Centre who are discussing this subject as part of their current programme.

DETAILS HAVE JUST been announced by the Yorkshire Council for Further Education of the specialised and advanced short courses for scientists, technologists and executives they are sponsoring in the county. There are several of interest to lighting engineers, notably:
The measurement of colour, at Bradford Institute of Technology, ten evening lectures starting Oct 9.
Efficient lighting for the retail trades, at Huddersfield College of Technology; seven evening lectures starting Oct 10.

Lectures on Orthoptics and on Spectroscopy are planned for 1962 at Bradford and Rotherham, respectively. Applications are to be made to the Registrars at the relevant colleges.

THE RESULTS OF the City and Guilds of London Institute examinations in Illuminating Engineering held in May were recently announced, as follows:

INTERMEDIATE GRADE
First Class: H. G. Blackhurst, E. G. Chapman, R. H. Chambers, G. M. Collins, J. Crawford, R. Davis, J. T. Ledger, G. R. Lloyd, J. W. Mansell, W. S. Shaw.
Second Class: B. Appleyard, C. L. Ashley, A. T. Barrett, R. Beck, W. A. Black, D. J. Bridgers, F. E. Cameron, G. H. Clark, R. E. Collins, B. B. Cooper, W. Devonport, R. A. Duller, A. Dumville, C. A. Crainger, C. J. T. Greenslade, J. S. Harrison, D. H. Lambert, S. Leat, J. B. Love, D. S. McIntosh, B. H. Myers, E. A. Perry, M. Priestley, R. V. Thornton, W. B. Valentine, R. Whilesmith, D. H. Williams, J. R. Wylie, L. Zimbler.
FINAL GRADE (Papers 1 and 2)
First Class: R. G. S. Anderson, J. E. Chapman, F. M. Pigott.
Second Class: G. J. Potter, A. Wilson.
FINAL GRADE (Papers 1 and 3)
First Class: R. G. S. Anderson, J. E. Chapman.
Second Class: J. Ludlam-Taylor, G. J. Potter, H. R. Westmancott.

The results of the intermediate examination show considerable increases over last year; there were 10 first class and 29 second class passes, as against 7 and 10

last year. In the final examination, there were fewer passes; 10 this year, compared with 19 last year.

IES Meetings

LONDON

October 10
Presidential Address: The Society's contribution to lighting technology, by W. T. Souter. Royal Institution, Albemarle Street, W1, 6 p.m.

October 24
Hirst Research Centre visit; by ticket only.

CENTRES

October 2
BATH AND BRISTOL. Chairman's address. Gardiner's showroom, Bristol.

October 4
EDINBURGH. The new IES Code, by R. Croft. At YMCA, 14 South St, Andrew Street, 6.15 p.m.
SWANSEA. Chairman's address. S. Wales Electricity Board, Kingsway, 6 p.m.

October 5
GLASGOW. The new IES Code, by R. Croft. At the Institution of Engineers and Shipbuilders, 39 Elmbank Street, C2, 6.30 p.m.

October 9
LIVERPOOL. Chairman's address. Industrial Development Centre, Paradise Street, 6 p.m.
SHEFFIELD. Chairman's address. Grand Hotel, 6.30 p.m.

October 10
STOKE-ON-TRENT. Stage lighting, by B. Legge. North Stafford Hotel, 6 p.m.

October 11
NEWCASTLE-UPON-TYNE. Chairman's address. County Hotel, lunch.

October 12
CARDIFF. Chairman's address. Grand Hotel.
MANCHESTER. The new IES Code, by J. G. Holmes. N. Western Electricity Board, Town Hall Extension, 6 p.m.
NOTTINGHAM. Chairman's address. Electricity Centre, Carrington Street, 6 p.m.

October 17
NORTH LANCASHIRE. Presidential address, by W. T. Souter. N. Western Electricity Board, 19 Friargate, Preston, 6.30 p.m.

October 23
BATH AND BRISTOL. The new IES Code, by H. Hewitt. Gardiner's showroom, Bristol.
BIRMINGHAM. Floodlighting in colour, by J. W. Bessant. Chamber of Commerce, 75 Harbourne Road, Edgbaston, 6.30 p.m.
LEEDS. Office lighting, by R. G. Hopkinson. BLC, 24 Aire Street, 6.15 p.m.
LEICESTER. The new IES Code, by W. E. Harper. E. Midlands Electricity Board, Charles Street, 6.15 p.m.

October 24
LIVERPOOL. The new IES Code, by H. E. Bellchambers. Industrial Development Centre, Paradise Street, 6 p.m.

British Standards

B.S.3224:1961, *Lighting fittings for civil land aerodromes*. Section D1: *High-intensity elevated runway-light fittings;* 4*s*. 6*d*. Section D2: *Omni-directional elevated runway-lighting fittings;* 4*s*. 6*d*. Section D6: *High-intensity elevated runway-threshold lighting fittings;* 4*s*. 6*d*. Section D7: *Omni-directional elevated runway-threshold lighting fittings;* 4*s*. 6*d*.

All British Standards for lighting fittings for use at civil land aerodromes are now being published as sections of one standard, B.S.3224. For this reason, the standard bearing this number, *High-intensity elevated runway-lighting fittings*, has been renumbered as B.S.3224: Section D1. At the same time, three further sections of the standard have just been published. They specify requirements and tests for the photometric performance and essential mechanical and electric features of the fittings they cover. Lamps, however, are excluded. Guidance on the use of these fittings is given in B.S.1332, *Guide to civil land aerodrome lighting*.

B.S.1015: 1961, *Exciter lamps;* 5*s*.

In this first revision of a standard first published in 1942, the range of lamps has been extended to meet the current requirements of the manufacturers of 16 mm as well as 35 mm projectors, and some of the lamps originally included, but now no longer in current use, have been omitted. The standard covers dimensions and optical performance of a variety of lamps and as well as general overall dimension, now gives approximate filament dimensions, together with a clarification and amplification of the requirements relating to the filament operating position. Values are specified for initial light output, current consumption, minimum lumen output maintenance and life and a detailed procedure is laid down for sampling and batch testing.

BLC Activities

INTEREST THIS MONTH is, of course, devoted almost entirely to the Council's Office Lighting Campaign, which gets off to a flying start with an 'Office Lighting Week', from October 23 to 28. Activities planned for this week include direct mail and other advertising (for which a standard format has been prepared for use by BLC members), window displays, demonstration installations, conferences and lectures. An exhibition 'One hundred years of office lighting' will open at the beginning of the week at the Council's lighting centre in London and others are arranged in provincial centres, whilst electricity board staffs and electrical contractors are being encouraged to carry out light meter checks of existing installations to show users where their office lighting falls below recommended standards.

OF PARTICULAR INTEREST to architects, lighting engineers, electrical engineers, and consultants in the Southampton area is a series of four lectures the Council has planned for successive Tuesdays later this year. They are to take place at the Technical College, St Mary St, Southampton, starting at 7 p.m. and will comprise: Nov 14, Recent developments in electric lamps, by G. V. McNeill; Nov 21, The new IES Code, by C. Dykes Brown; Nov 28, The economics of lighting, by W. Robinson; Dec 5, The lighting of commercial buildings, by L. H. Hubble. Details may be obtained from the BLC at Brettenham House, Lancaster Place, London WC2.

Correspondence

Vehicle direction indicators

In the 'Notes and News' feature of your August issue, you refer in the section reporting lighting matters discussed in Parliament, to direction indicators on vehicles and the Minister's reply to questions. You mention the Ministry's new draft regulations, which, as has been stated, have been based on recommendations of the Economic Commission for Europe, to be expected shortly. It is, however, perhaps worth noting that these recommendations themselves originated in the standards of the Society of Motor Manufacturers and Traders. They represent, therefore, the work and the ideas of the British motor industry, which have in turn, proved acceptable to the Europeans. It would, of course, have been nice if we could have persuaded our own Ministry to adopt these ideas first instead of having to go to Europe and sell them there.

J. H. NELSON
Birmingham

Errata

WE WISH TO POINT OUT that, in our reference on this page last month to recent appointments in the Lighting and Heating Group of the General Electric Co Ltd, the new publicity manager should have been given as Mr G. Cole and not Mr G. F. Cole.

IN THE ARTICLE 'Glare index evaluation' on page 269 of the September issue, the interpolation chart for question 2 should have shown the initial glare index obtained in the first interpolation to have been 23·24; most readers will have realised that this figure was correctly given in the text.

Situations

Vacant

Crompton Parkinson Ltd require additional LIGHTING SALES STAFF for Greater London. Vigorous sales attitude should be supported by lighting experience of offices, shops, etc. Position permanent, pensionable. Details of past record, etc, to S3V, Crompton House, Aldwych London, WC2.

Postscript

ALTHOUGH IT IS SOME TIME AGO NOW, many of my readers will no doubt remember the publication *Lighting of Factories*, in the BRS Factory Building series. Its companion booklet, *Colouring in Factories*, appeared earlier this year. It appears under the aegis of the Factory Building Research Committee, and is by H. L. Gloag, who was part author of the earlier study. Mr Gloag, as an architect, approaches the lighting and colour problem quite properly from an architectural rather than a scientific point of view. Let me say at the outset that this is an excellent study which, together with the Ministry of Education's bulletin, *Colour in Schools*, should be read by every lighting engineer. The principles of light and vision in relation to colour are clearly stated. The style is more discursive than that of the schools bulletin, so that it is more difficult to obtain an answer to a specific problem, but on the other hand it is all there if you read carefully and look for it.

Gloag seems to belong to the 'compensation' school: he uses colour to neutralise features of an environment. If a machine shop, with grey stone floor and areas of bare metal, has a cool effect, the balance can be 'corrected' by soft warm colouring on the walls with the addition of stronger colours in strategic places. In general Gloag seems to favour restrained colouring in factories, but he advocates 'limited use of bolder colouring' to add invigoration.

Some interesting features of the bulletin come at the end, where Gloag deals with windowless or 'semi-windowless' factories. For the former he advises cool colouring, to create a simple unconfused appearance, and 'one which helps to give the occupants a sense of direction'. He believes that danger can occur because, in an emergency, the lack of windows makes orientation difficult. Colour can assist here. For 'semi-windowless' factories he advocates a careful choice of colours for walls, so that the colour of a wall seen at one end by daylight and at the other predominantly by artificial light may not be seen to change in an unpleasant way. He tabulates a wide range of BS 2660 colours, listing the subjective colour changes which occur under different types of fluorescent lamp, grouping these changes into 'no perceptible change', 'perceptible but acceptable', and 'unacceptable change'. The 'natural' and 'colour matching' types of lamp come well out of this inquest, but the 'de luxe warm white' shows a number of 'unacceptable' changes. The comparisons are presumably made with natural daylight, but if this is stated I could not find the reference. This table could well be of the greatest use to colorists, and I hope Mr Gloag will some day offer a paper to the IES about his experiments and tell us more about his observing conditions.

MY COPY OF ILLUMINATING ENGINEERING, from New York, reaches me rather late, no doubt because it comes by sea mail. It so happened that the June number arrived as I was about to leave for my summer holiday, which meant that it stayed unopened until my return, and had to take its turn in the queue of paper awaiting attention. This was unfortunate, because there is a very interesting paper by Logan and Berger which merits much more study than I have been able to give it. Logan and Berger are trying to apply 'information theory' to the study of lighting, and in particular to analyse the reasons why two lighting installations, which provide the same illumination level and 'which meet the same gross visual comfort criteria', may result in one scene being clearer and sharper than the other. Resisting the temptation to comment on what is meant by 'gross' in this context, I would say that this is a question which has worried many of us who have to give opinions on the merits of 'shadowless lighting'. Logan and Berger liken a scene to a television picture, and make use of an optical device called an autocorrelator to analyse the contained contrast in a scene. The procedure is to prepare two identical pairs of transparencies of the same scene, with different lighting in the two, and to obtain the 'autocorrelation curve' for each of the two scenes. This curve is a function of the transmission of the superimposed transparencies when they are in coincidence and when they are displaced by very small increments of distance. A comparison of the curves will indicate the relative amount of visual information revealed by the two different lighting systems.

The autocorrelator is a very simple piece of apparatus optically, but it has to be built to high precision mechanically in order to reproduce very small relative movements of the two transparencies with accuracy. It is, therefore, likely to be expensive. When the autocorrelation curves are obtained, there is the problem of interpreting them in terms of subjective impressions, and it seems that this most important stage has not reached even a partial solution. Finally, there remains the problem of preparing identical transparencies each of which reproduces the full luminance range of the original scenes. So Logan and Berger have a great deal of work to do before they have the answer to the problem which they set out to solve, but at least they have set out, and by an original route. I wish them every success and look forward to their next paper.

DURING THE PAST FEW WEEKS it has been possible to see the planets Jupiter and Saturn close together in the southern sky low down near the horizon. As everyone knows, Saturn is famous for his rings, but a telescope with a magnification of ten times is necessary to see them. Yet even in classical times Saturn, or Kronos, was depicted with a ring of serpents round his head, and it has been argued that this shows that it must have been possible with very clear desert night skies and phenomenal eyesight for the ring system to have been seen before the invention of the telescope. Perhaps a mirage effect could magnify the image of the planet low on the horizon as it has been this year. Do there exist people with quite extraordinarily acute distance vision?

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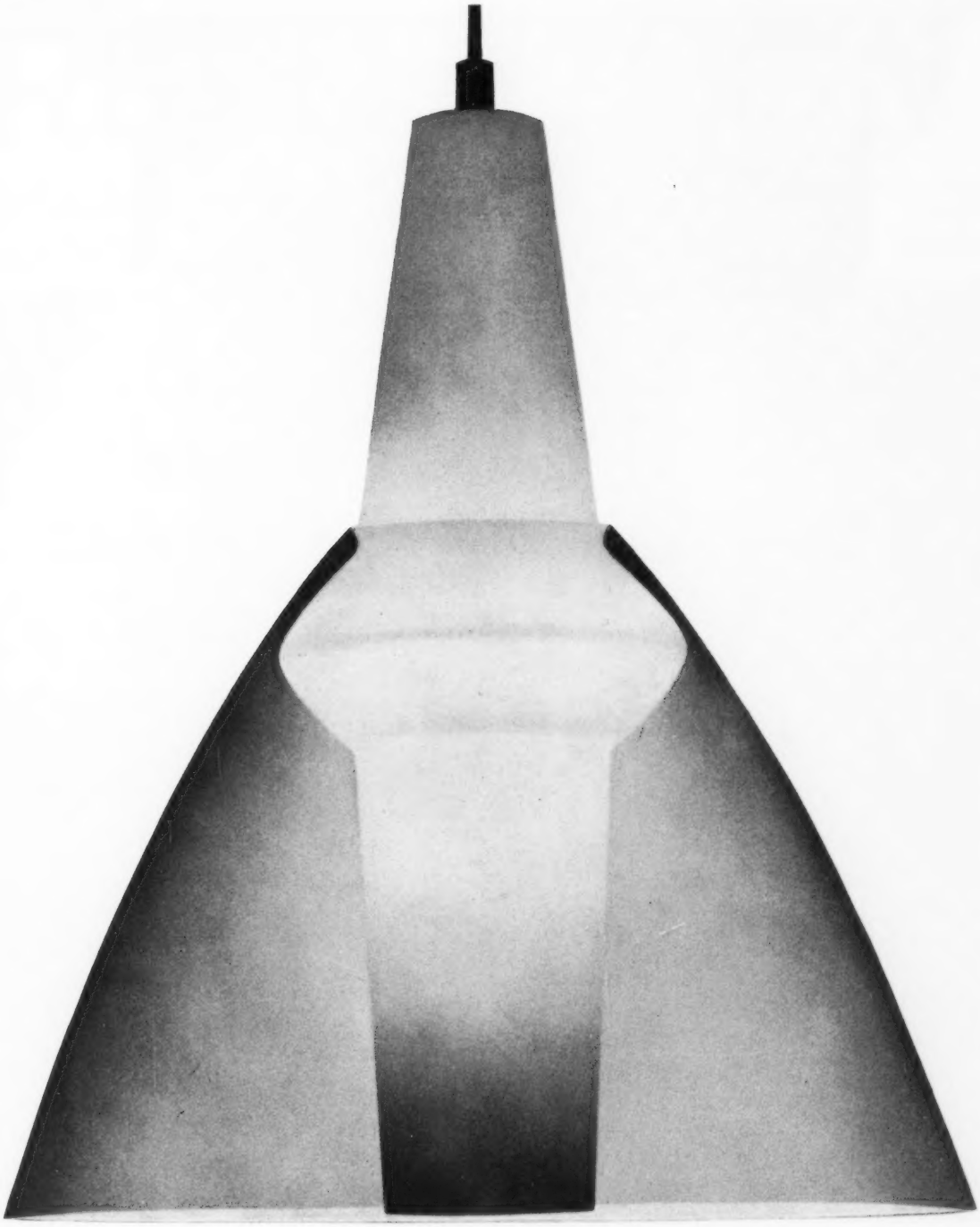

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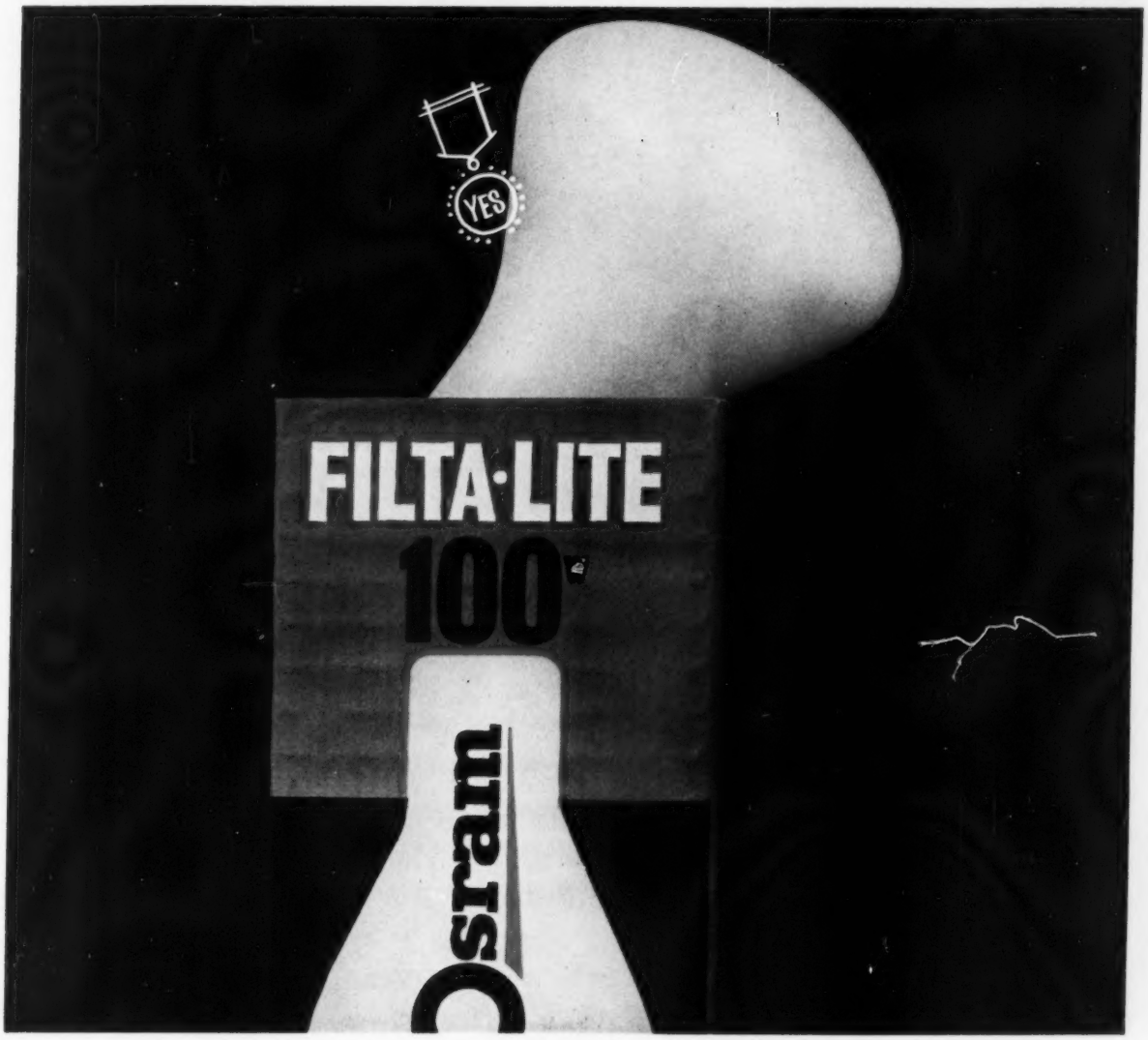

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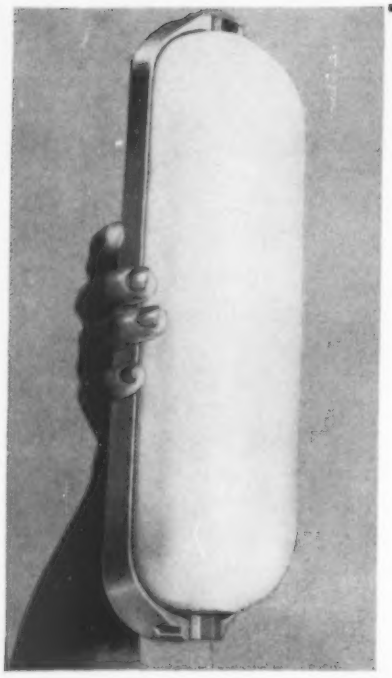

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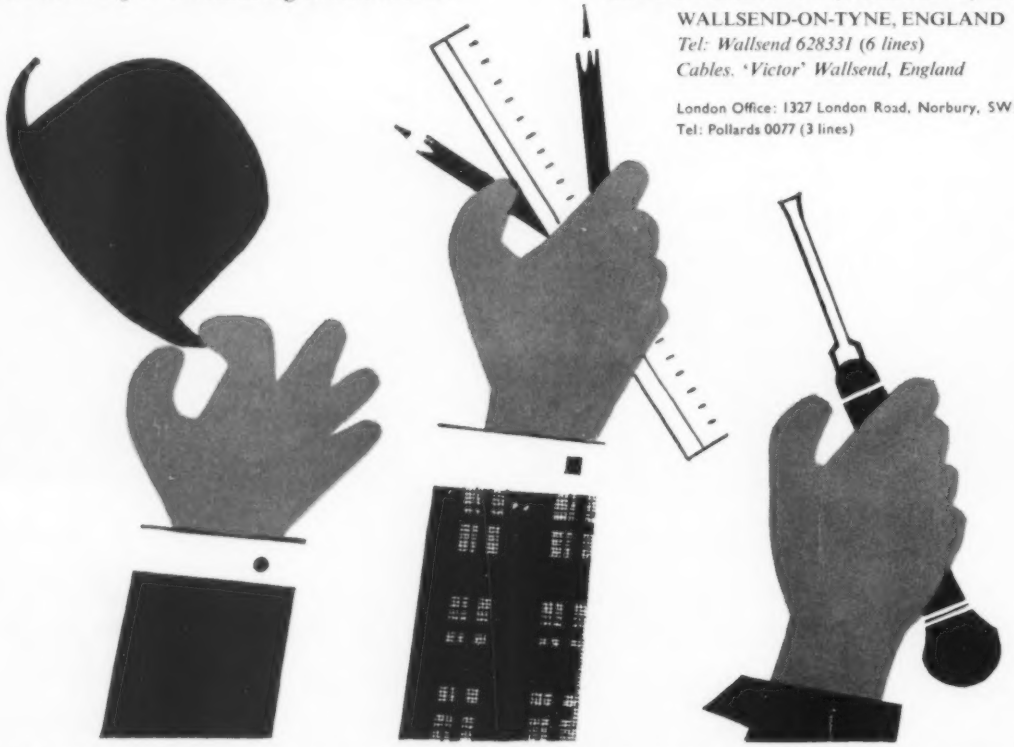

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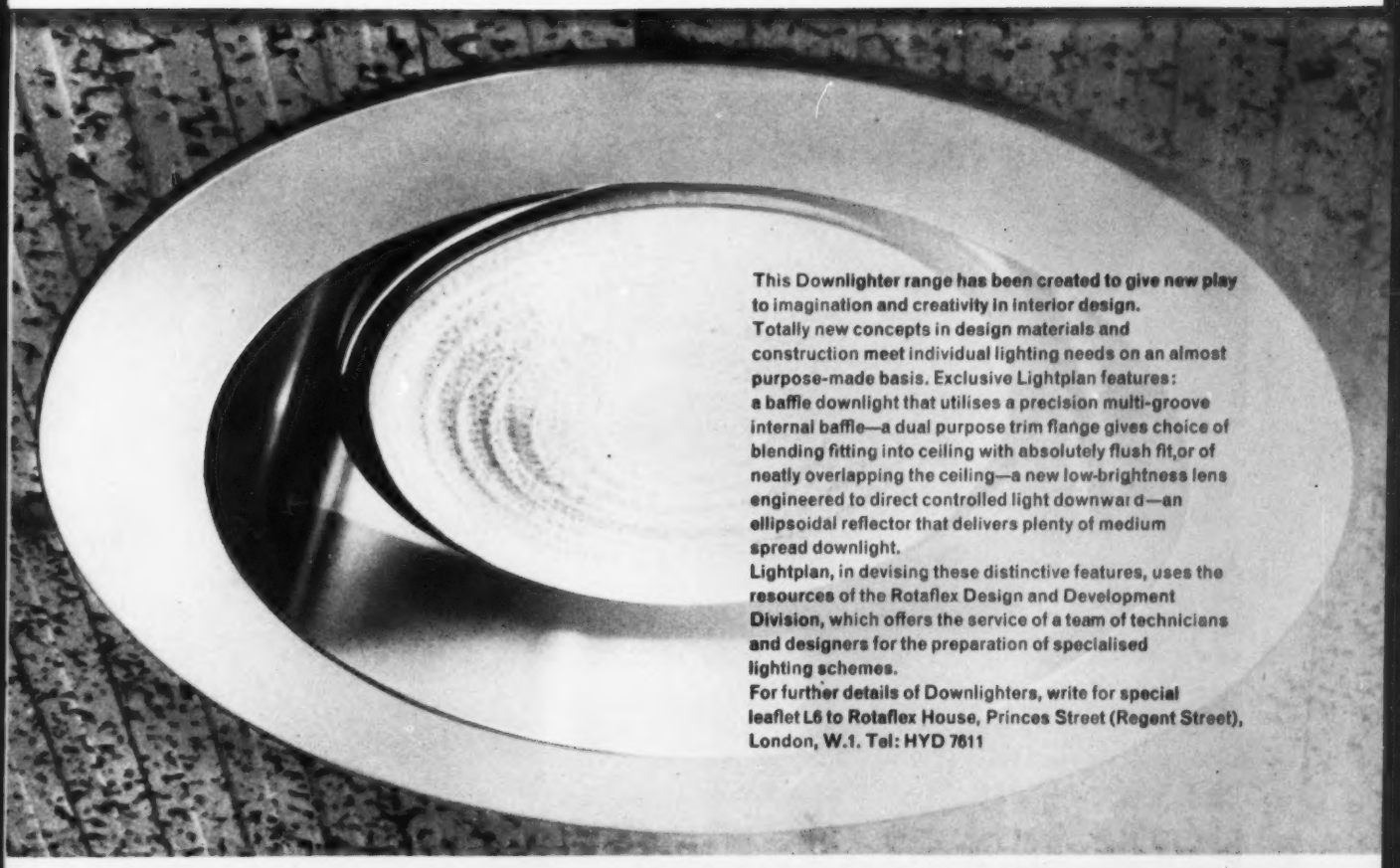

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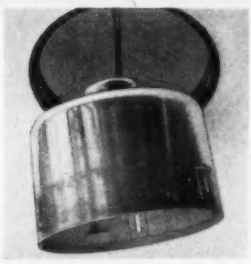

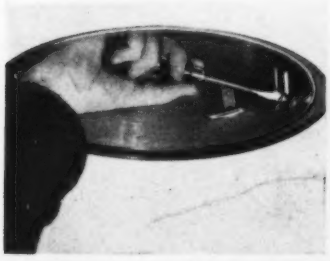

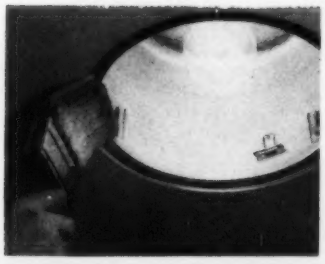

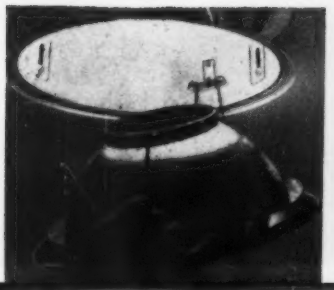

floating lens

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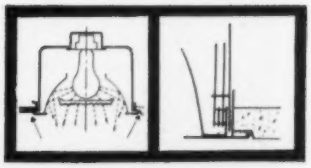
1 2
3 4
5 6



1 Dual-purpose trim flange used as a plaster ring is fixed by plaster lugs wired to metal lathing. The plaster retainers act as spacers and lock the plaster ring in position (for dry ceilings reverse dual-purpose trim flange).
2 Dual-purpose trim flange flush with ceiling line in completed plaster work. The body of the fitting is shown connected to the electrical installation ready for fixing.
3 Positive fixing for the body is provided in the dual-purpose trim flange. Slots permit accurate levelling with trim flange.
4 Fitting illuminated, painting in progress. Uninterrupted ceiling area (no cutting-round the soffit ring) ensures a fast, clean job.
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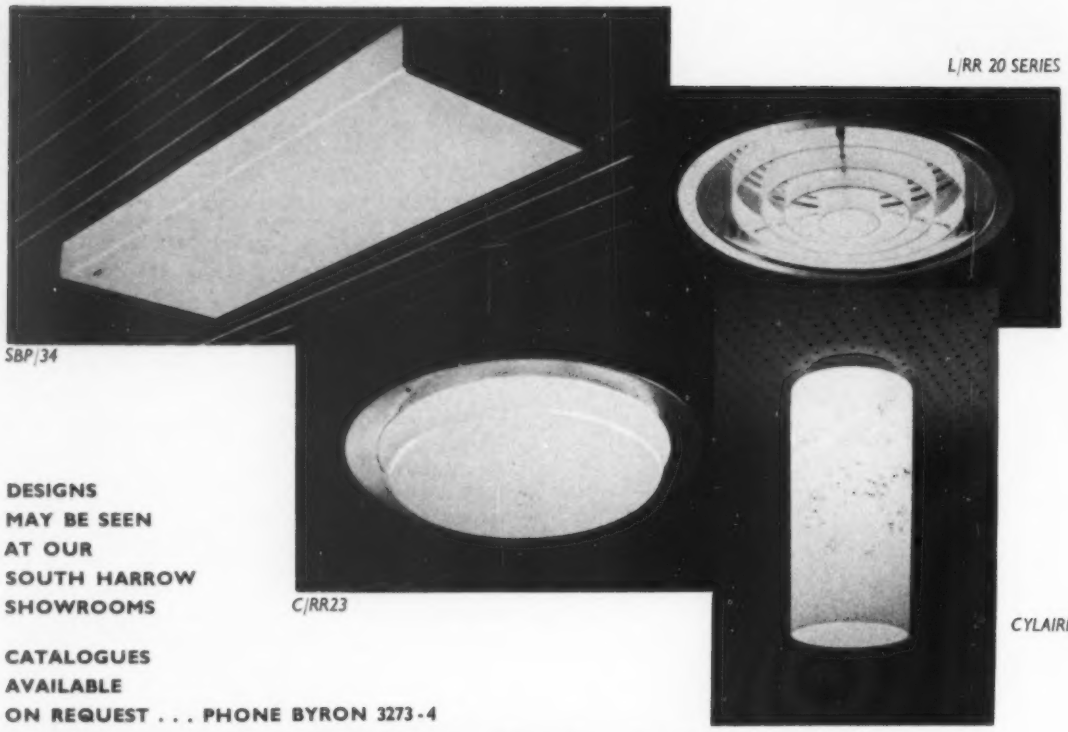

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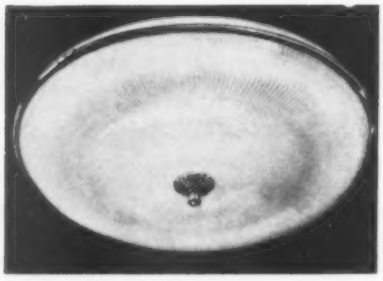

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Victor Products Ltd.	xx

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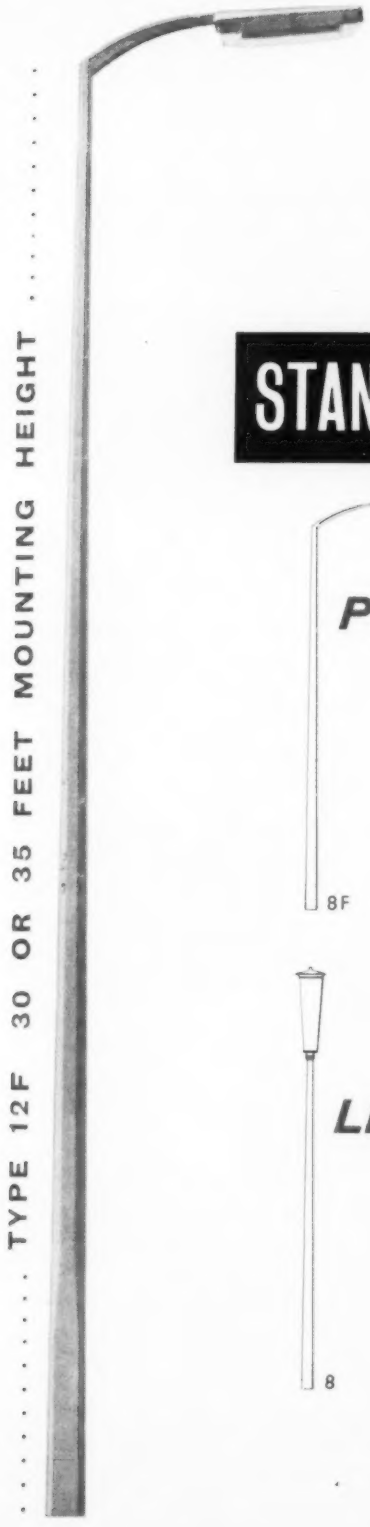


STANTON AND STAVELEY

Prestressed

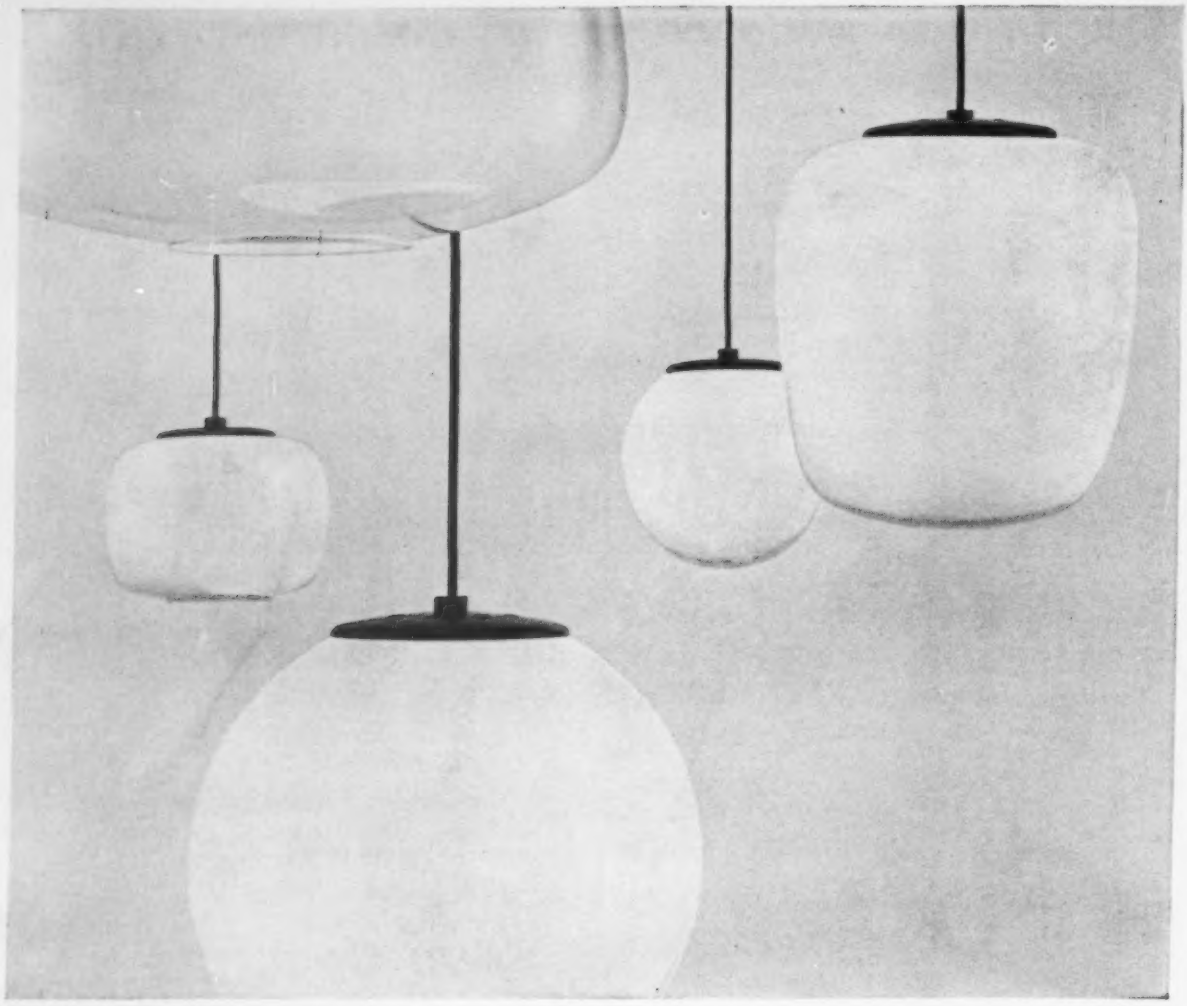
Spun Concrete

Lighting Columns

Our wide range of spun concrete lighting columns has been extended by the introduction of a prestressed concrete column for 30 ft and 35 ft mounting height.

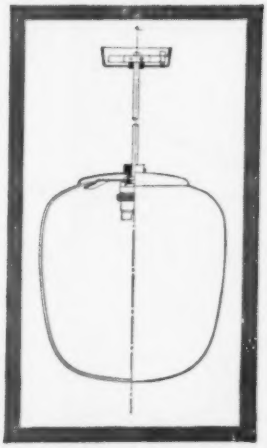
These columns will be available with either straight or curved brackets both of which have been approved by the Council of Industrial design.

STANTON AND STAVELEY SALES LIMITED NEAR NOTTINGHAM



Atlas 'MAYFAIR' a new range of commercial glassware

Here is something refreshingly different for boardroom or typist pool, reception area or executive office . . . the Atlas 'Mayfair' range of commercial glassware. These elegant yet efficient fittings are available in three distinctive shapes and two sizes, providing enough variety to satisfy the requirements of large and small installations. Easily installed and maintained, the fittings have opal glass bowls which contrast with the black PVC suspension. Rod suspension is offered as an alternative. Although so practical and striking in looks, Atlas 'Mayfair' fittings are surprisingly competitively priced. Full details will gladly be sent on request.



atlas/ *ATLAS LIGHTING LIMITED · THORN HOUSE · UPPER ST. MARTIN'S LANE · LONDON WC2*

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